Mississippi River Delta

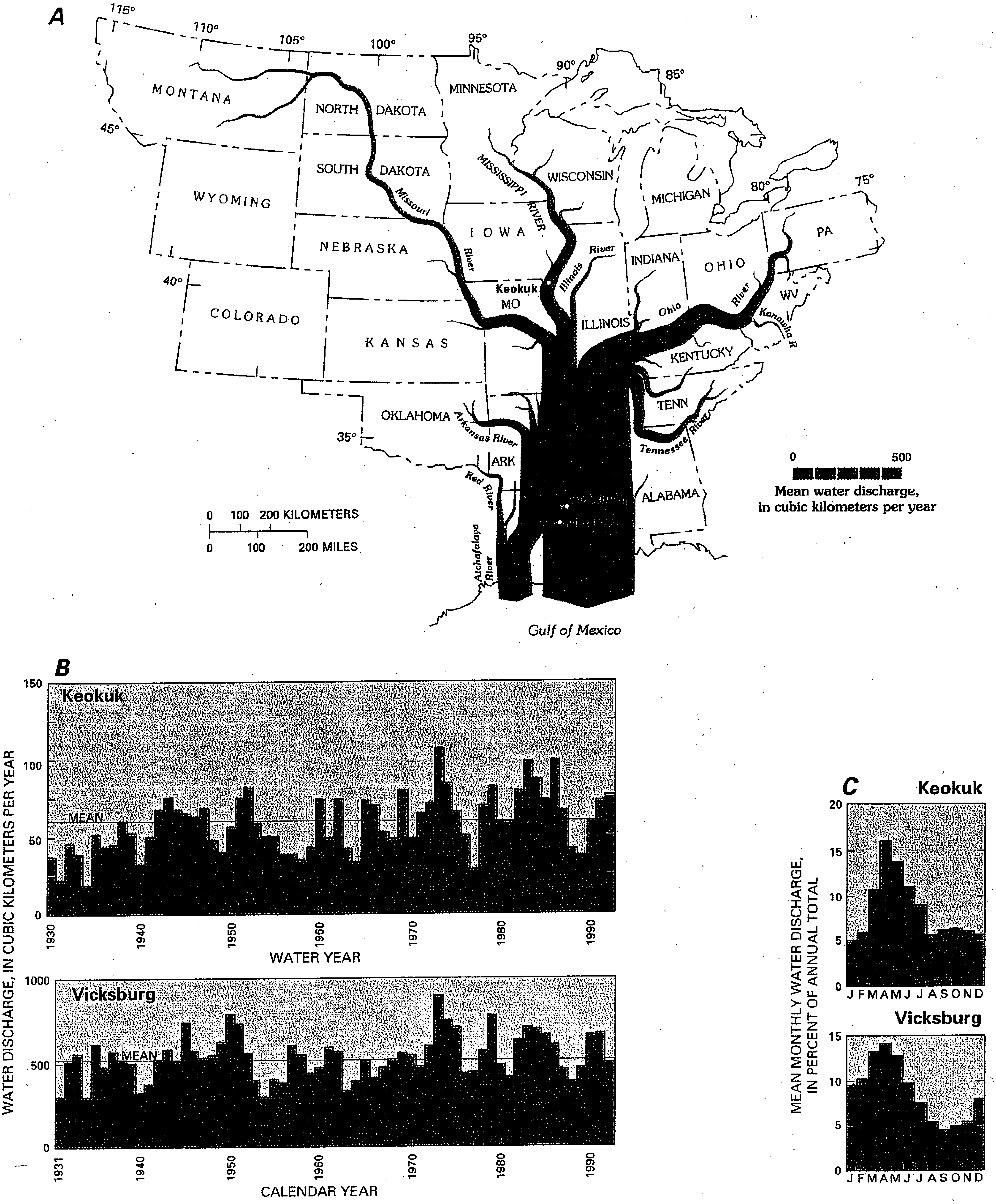
24 Sept 2007

ROBERT H. MEADE
RESEARCH HYDROLOGIST EMERITUS
U.S. GEOLOGICAL SURVEY

MS 413, BOX 25046
DENVER FEDERAL CENTER
LAKEWOOD, CO 80225-0046
USA

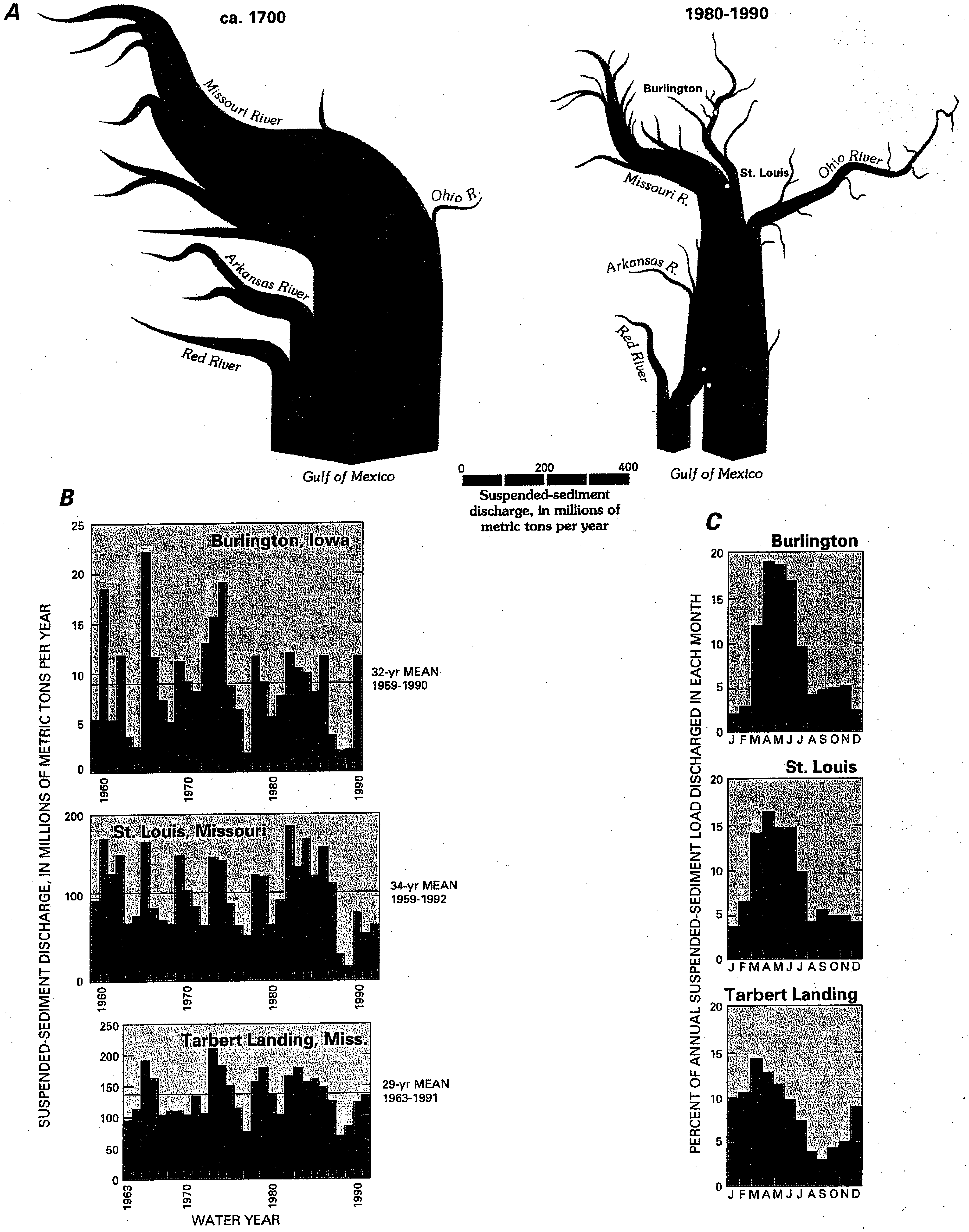
674-7001 (home)
PHONE (303) ~~236-5009~~
FAX (303) 236-5034
email: rhmeade@usgs.gov

Figure 5 *Water Discharge*

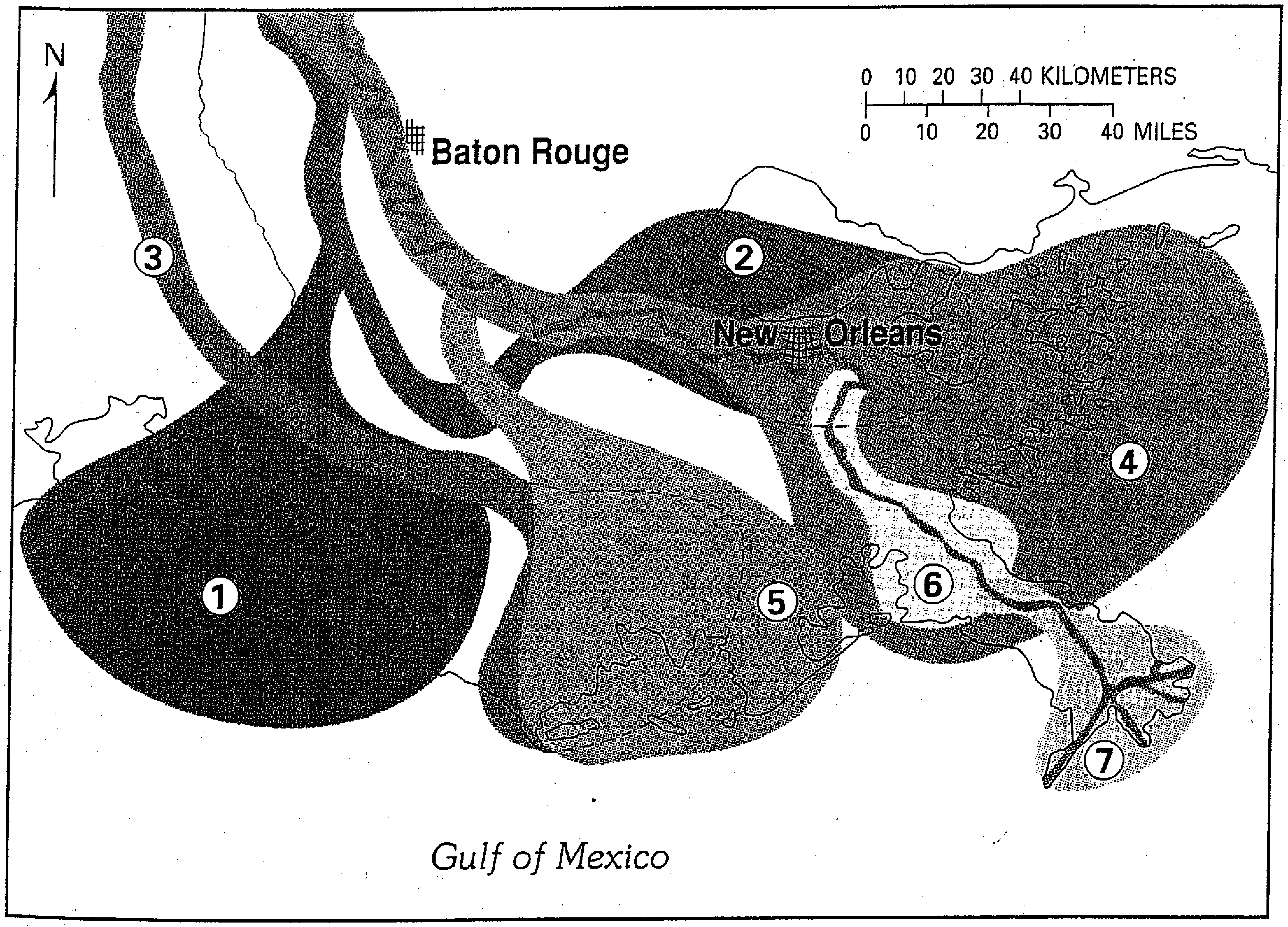


USGS Circular 1133 (1995)

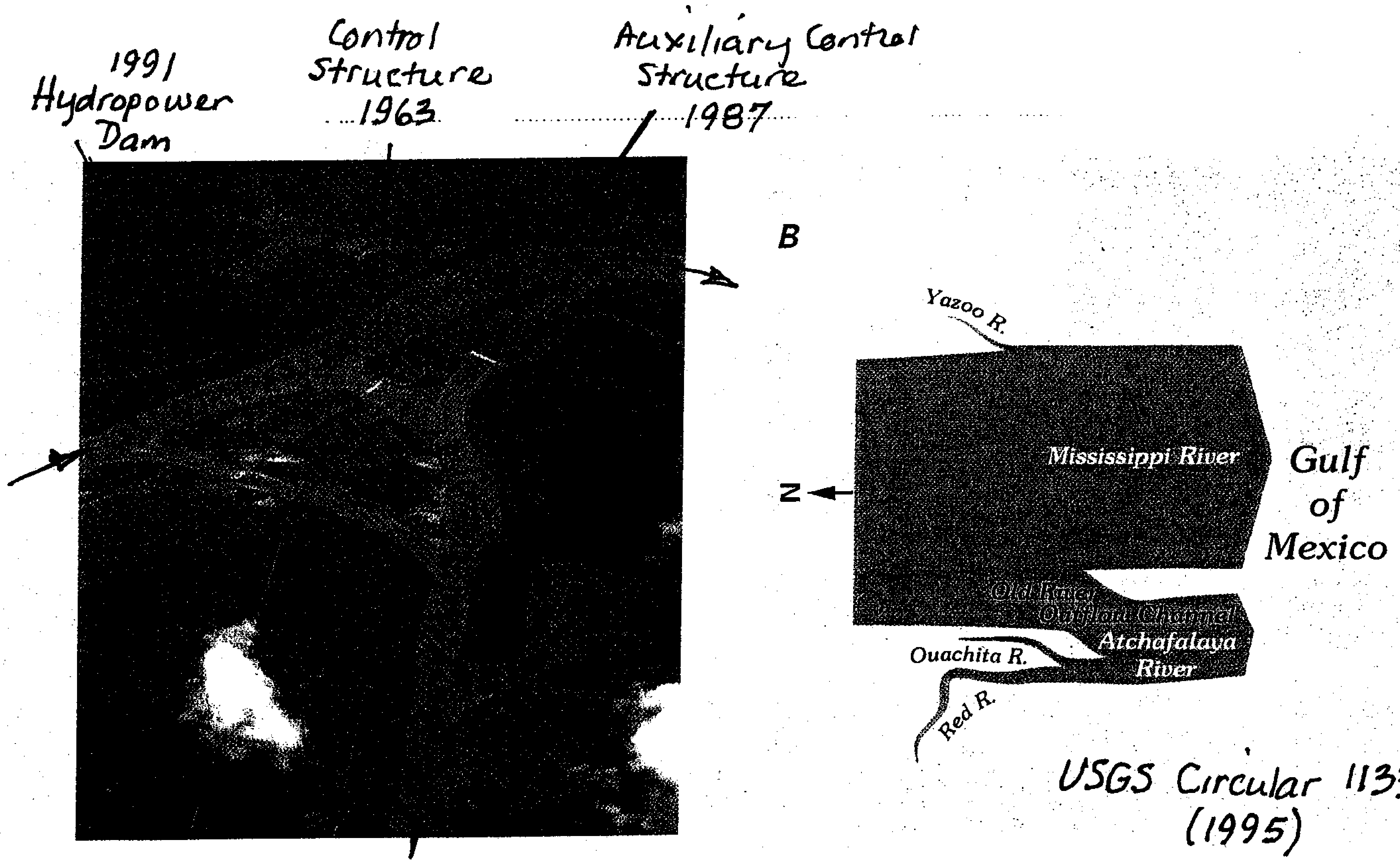
Figure 6 *Suspended-Sediment Discharge*



USGS Circular 1133
(1995)



Redrawn from: Kolb, C.R., and Van Lopik, J.R., 1958, Geology of the Mississippi River deltaic plain, southeastern Louisiana: U.S. Army Engineer Waterways Experiment Station Technical Report 3-483, 120 pp.



USGS Circular 1133 (1995)

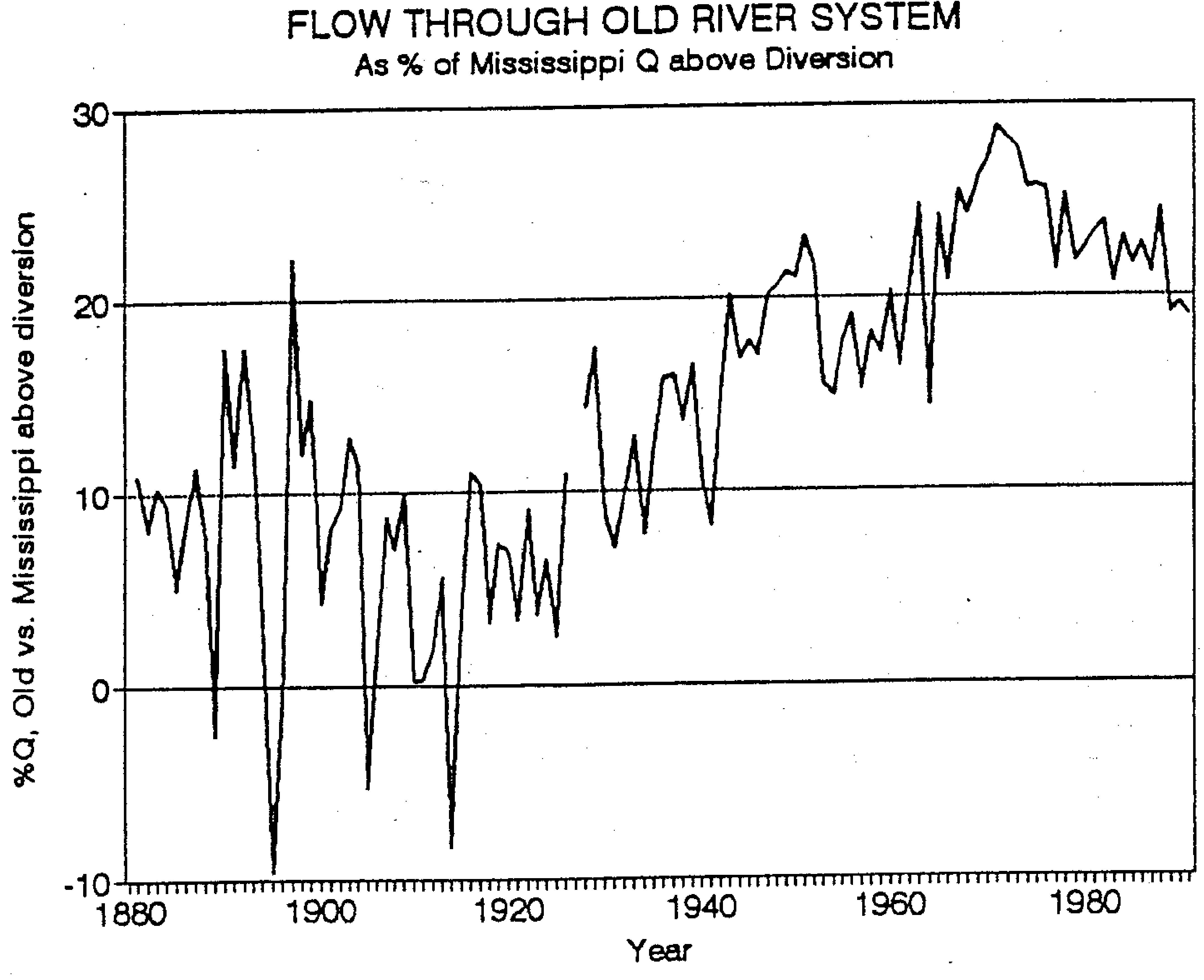


Fig. 4. Increasing percentage of the Mississippi River flow diverted first naturally, then artificially, through Old River. Negative numbers show years in which the Red River provided flow to the Mississippi, when Old River was bidirectional.

Mossa, J., 1996, Sediment dynamics in the lowermost Mississippi River: Engineering Geology v. 45, p. 457-459.

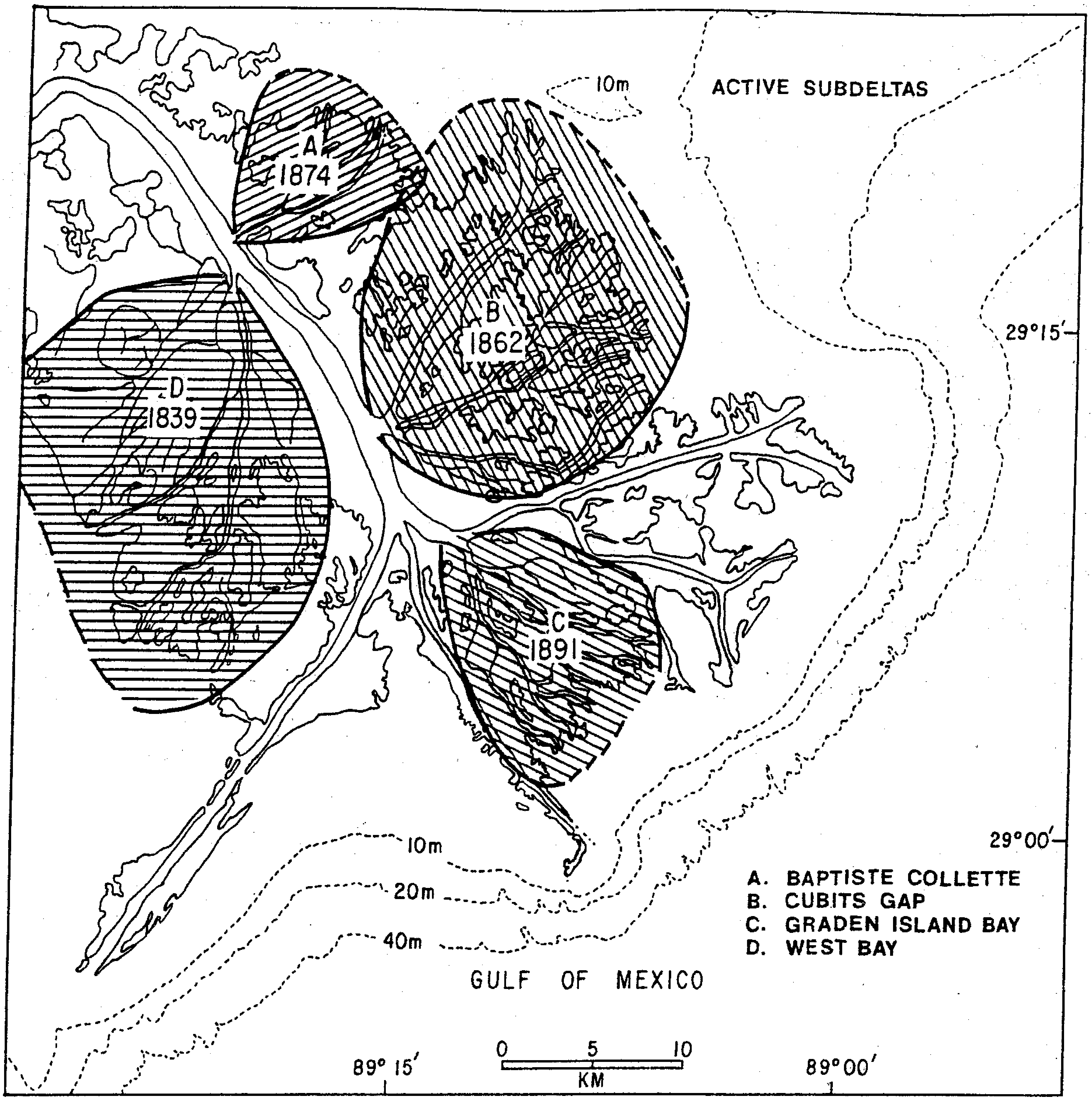


Fig. 7. Index map showing the four active subdeltas of the modern Mississippi Delta. Dates indicate years of the crevasse openings.

Wells, J.T., 1996,
Subsidence, sea-level rise,
and wetland loss in the
Lower Mississippi River
Delta, in Milliman, J.D.,
and Haq, B.U., editors,
Sea-level rise and coastal
subsidence: Causes,
consequences, and strategies:
Dordrecht, Kluwer,
p. 281-311.

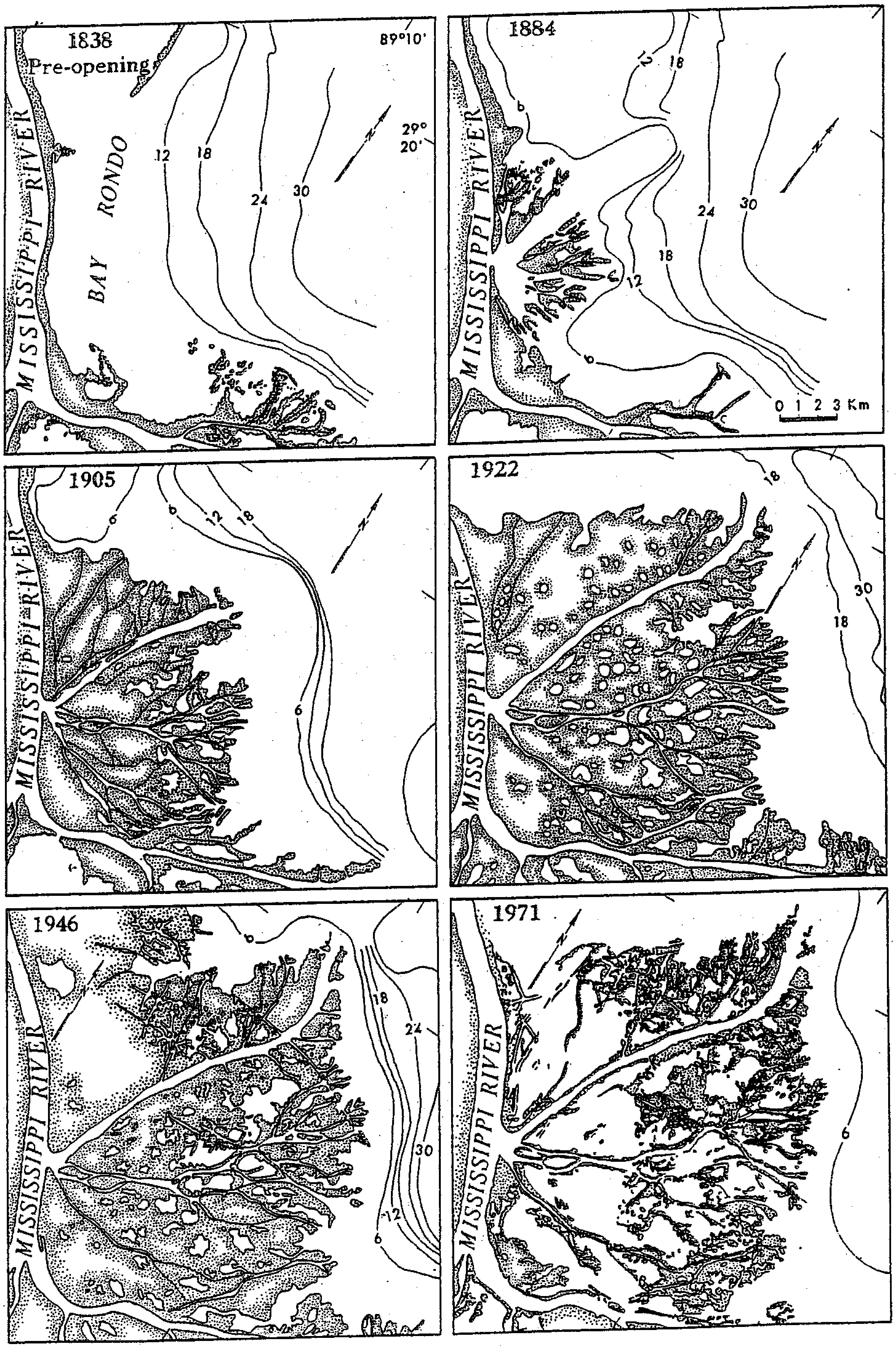


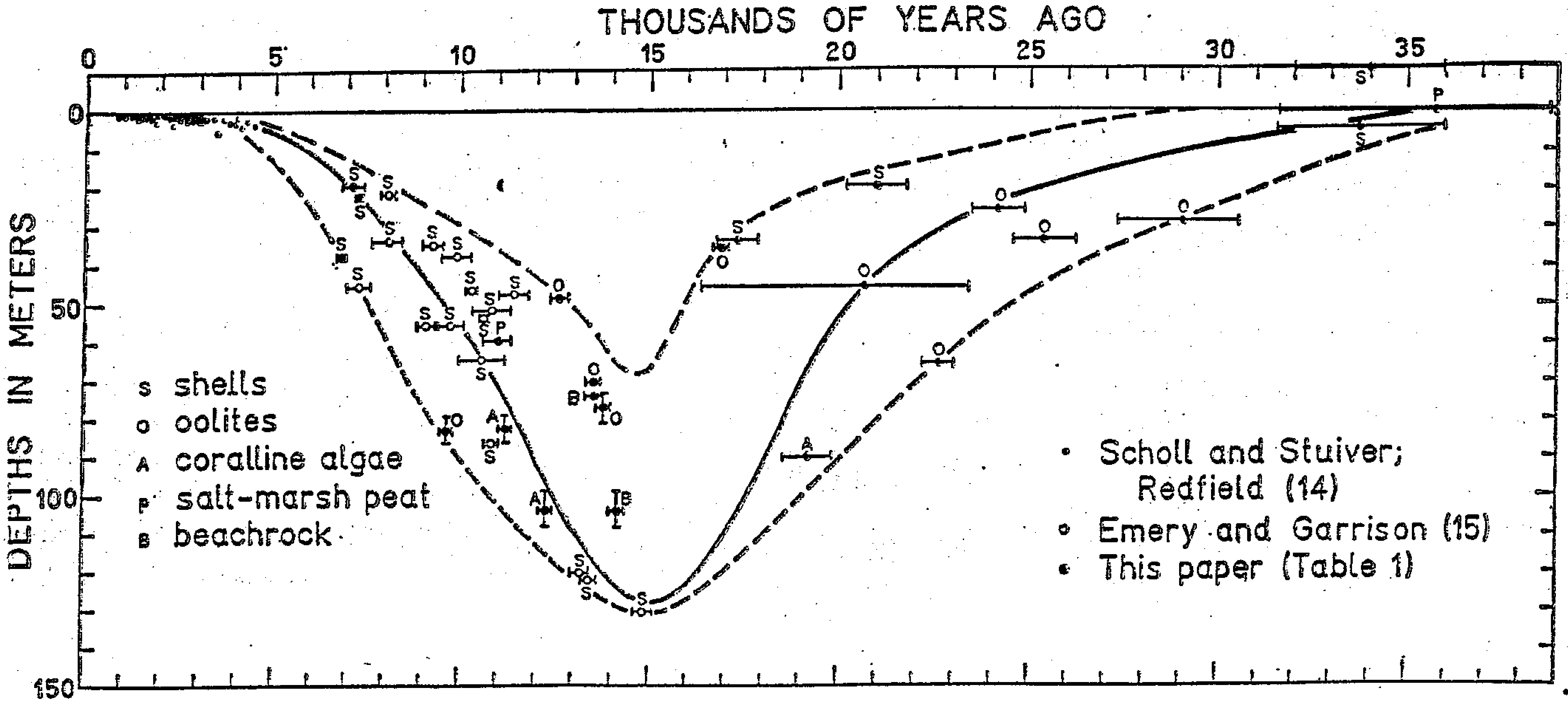
Figure 6. Historic maps illustrating the development of Cubits Gap bay fill during the period 1838 to 1971.

Coleman, J.M., 1988,
Dynamic changes and
processes in the
Mississippi River delta
Geol. Soc. America
Bull., v. 100, p. 999-
1015

Stanley, D.J., and Warne, A.G., 1994, Worldwide initiation of Holocene marine deltas by deceleration of sea-level rise: Science, v. 265, p. 228-231.

Table 1. Listing of oldest published dates (in radiocarbon years B.P.) in basal sections of Holocene eltas considered in this report. Dates preceded by ">" symbol record ages from above the very se of delta section. Delta positions, as indicated by the code in the first column, are shown in Fig. 2; reference sources, denoted by the same code, are listed in (*11*).

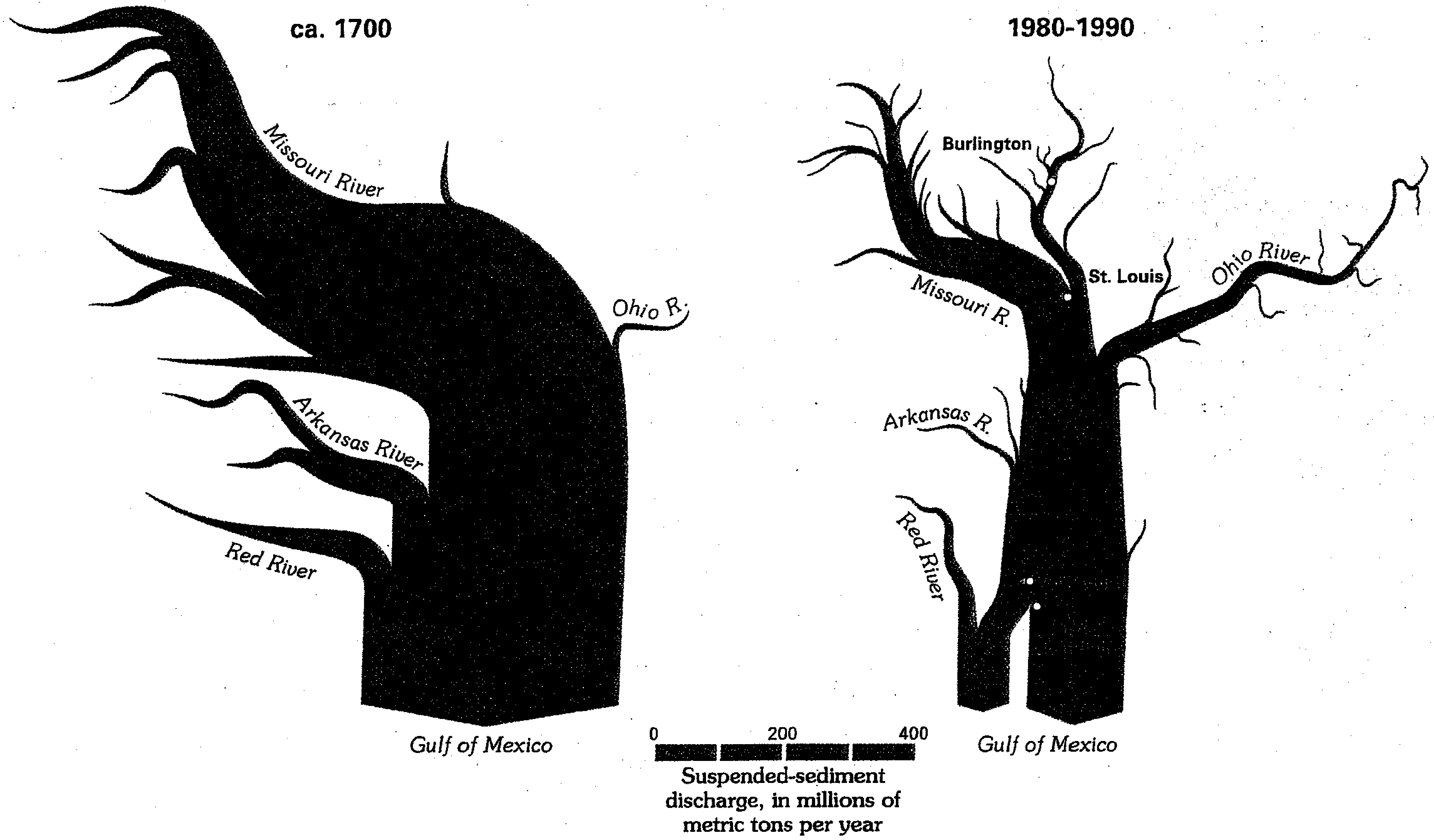
Code	Delta	Country	Age of (near) basal Holocene (years)
1	McKenzie	Canada	>6900 ± 110
2	British Columbia Fjord-Head Deltas	Canada	~8500
3a	Fraser	Canada	7300 ± 130
3b	Fraser	Canada	7960 ± 140
3c	Fraser	Canada	7650 ± 140
4	Snohomish	USA	~7000
5	Sacramento–San Joaquin	USA	6805 ± 650
6	Rio Grande	USA	~7000
7	Central Texas Coast Deltas	USA	>6670 ± 100
8a	Mississippi	USA	7240 ± 160
8b	Mississippi	USA	7880 ± 520
8c	Mississippi	USA	~6800
9	Baffin Island (SW)	Canada	7285 ± 200
10	Baffin Island (SE)	Canada	7100 ± 140
11	Acu	Brazil	>7020 ± 100
12	Jequitinhonha	Brazil	7900
13	Doce	Brazil	~7000
14	Saloum	Senegal	>6130 ± 130
15	Ebro	Spain	7680 ± 350
16	Thames Floodplain	England	7830 ± 110
17a	Rhine	Netherlands	8000
17b	Rhine	Netherlands	7420 ± 150
18	Alta	Norway	~7000
19a	Rhone	France	7860 ± 110
19b	Rhone	France	7200
20	Po	Italy	~7000
1	Acheloos	Greece	>5720
2	Gediz	Turkey	>7150 ± 110
23	Nile	Egypt	8140 ± 130
24	Poti	Russia	7900 ± 60
25	Volga	Russia	~8500
26a	Tigris-Euphrates	Kuwait	5980
26b	Tigris-Euphrates	Kuwait	8490 ± 100
27	Ganges	Bengladesh	7060 ± 120
28	Chao Phraya	Thailand	7800 ± 40
29	Mahakam	Borneo	~7500
30	Han	China	>6320 ± 240
31a	Yangtze	China	8320 ± 170
31b	Yangtze	China	7370 ± 140
32	Nobi	Japan	~6300
33	Sepik-Ramu	Papua, New Guinea	>7130 ± 250
34	Daly	Australia	7540 ± 110
35	Gilbert	Australia	>6430 ± 120
36	Georges	Australia	~7000



ig. 1. Depths and ages of sea-level indicators from the Atlantic continental shelf of the United States. The solid line is the inferred ea-level curve for the past 35,000 years; the dashed line, envelope of values.

Milliman, J.D., and Emery, K.O., 1968, Sea levels during the past 35,000 years: Science, v. 162, p. 1121-1123.

Figure 6 *Suspended-Sediment Discharge*



USGS Circular 1133 (1995)

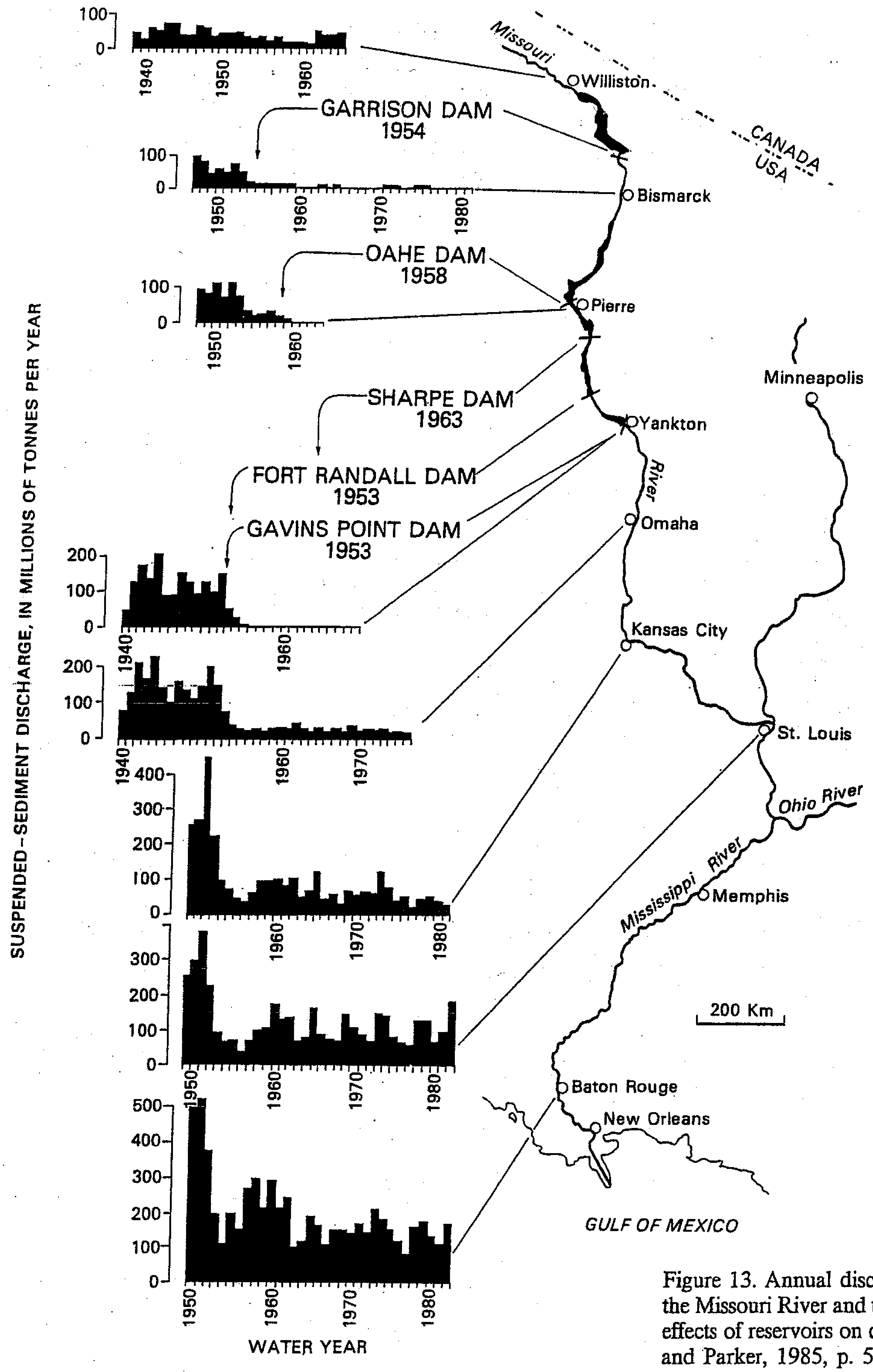


Figure 13. Annual discharges of suspended sediment at six stations on the Missouri River and two stations on the Mississippi River showing the effects of reservoirs on downstream sediment loads, 1939–1982 (Meade and Parker, 1985, p. 52; compiled from data of U.S. Army Corps of Engineers and U.S. Geological Survey).

USGS Water-Supply
Paper 2275 (1985)

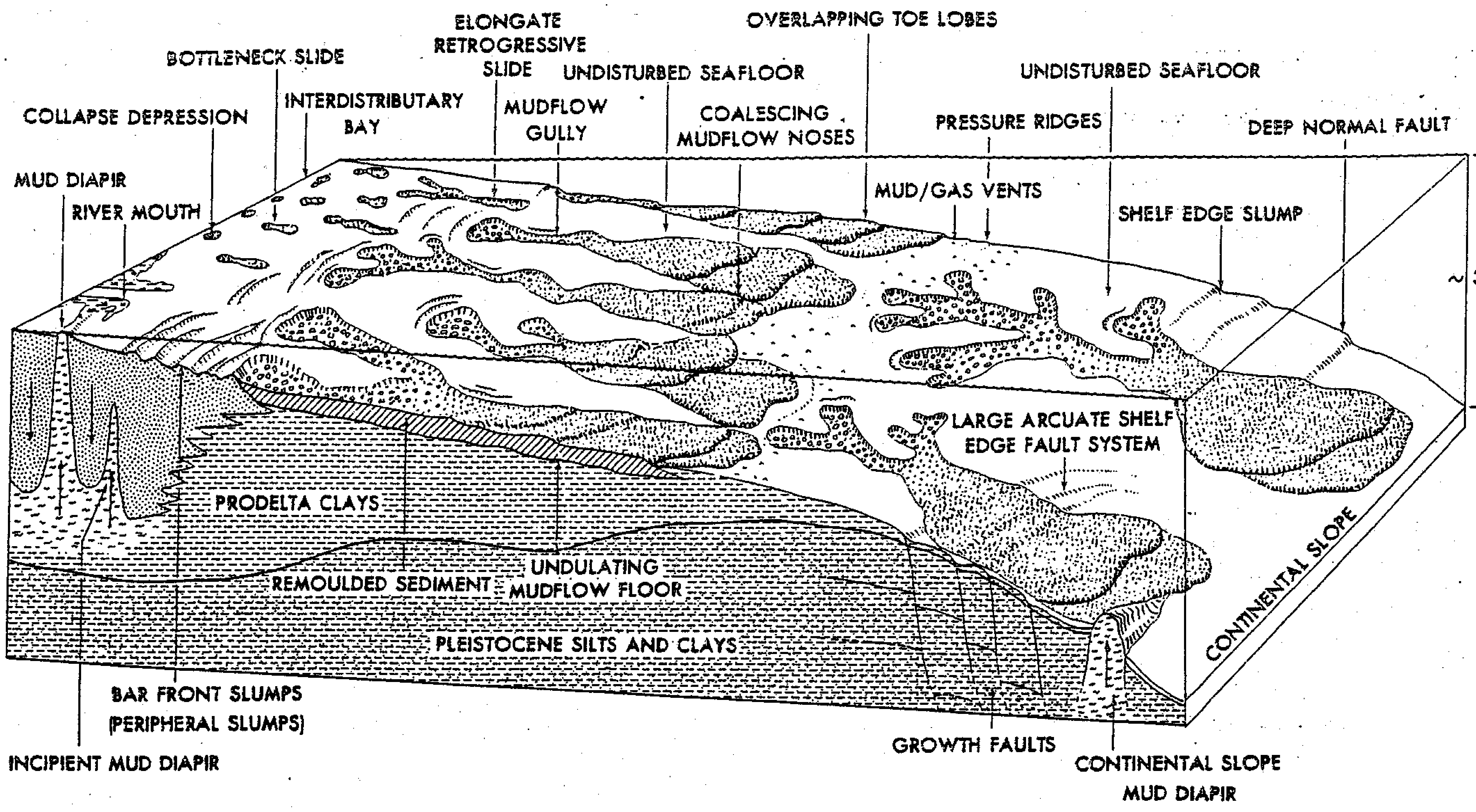


Figure 13. Schematic diagram illustrating the types of subaqueous sediment instabilities in the Mississippi River delta offshore. From Coleman and Prior, 1980.

Coleman, J.M., 1988,
Dynamic changes and
processes in the
Mississippi River delta:
Geol. Soc. America Bull.,
v. 100, p. 999-1015.

Geological Society of America Bulletin, v. 100, p. 999–1015, 24 figs., July 1988.

Dynamic changes and processes in the Mississippi River delta

1888
1988
CENTENNIAL ARTICLE

JAMES M. COLEMAN *Coastal Studies Institute, School of Geoscience, Louisiana State University, Baton Rouge, Louisiana 70803*

ABSTRACT

Research in the modern delta of the Mississippi River has revealed short-term changes and processes that are of significant magnitude. Deltaic lobes, each lobe covering an area of 30,000 sq km and having an average thickness of 35 ~~k~~m, switch sites of deposition on an average of every 1,500 yr. Through short periods of geologic time, this process results in a relatively thick accumulation of stacked deltaic cycles covering extremely large areas. Within a single delta lobe, and operating on an even higher frequency, are bay fills and overbank splays. Bay fills, having areas of 250 sq km and thickness of 15 m, require only 150 yr to accumulate. Four major events have taken place in the modern Balize delta since 1838. Overbank splays are much smaller, covering areas of less than 2 sq km and having thicknesses of 3 m, but are associated with high floods on the river. At the river mouth, continued progradation of the distributary channel can form distributary mouth sand bodies that have dimensions of 17 km long, 8 km wide, and a thickness of 80 m in a period of only 200 yr. Differential sedimentary loading at the river mouth results in formation of diapirs that display vertical movements in excess of 100 m in a period of 20 yr. On the subaqueous delta platform, sediment instabilities operate nearly continuously, mass-moving large quantities of shallow-water deposits to deeper-water environments via arcuate rotational slides and mudflow gullies and depositional lobes. All of these changes and processes operate at differing spatial and temporal scales, but all result in deposition of large volumes of sediment over extremely short periods of time.

Subsidence, Sea-Level Rise, and Wetland Loss in the Lower Mississippi River Delta

John T. Wells

ABSTRACT: Since late Cretaceous, depocenters with oscillating deltas and migrating shorelines have provided a fundamental geologic rhythm to the coast of Louisiana. Sites of deltaic sedimentation have shifted, sea level has risen and fallen by more than 100 m, and sequences of preserved deltas have been vertically stacked in the geologic record. This paper summarizes, in the form of a case history, recent changes in the modern Mississippi River Delta with special emphasis on the causes for geometrically increasing rates of wetland loss that have been experienced since the turn of the century. Rates of relative sea-level rise and discharge of freshwater down the main stem of the Mississippi River (north of Louisiana) appear to have been constant throughout the 1900s, indicating that the demise of the Mississippi Delta is probably a result of an inadequate sediment supply and an inefficient sediment delivery network. The combined effects of levees that prevent overbank flooding and funnel sediments to deep water, upstream dams that trap sediments in the Missouri and Arkansas River basins, and formation of a new delta lobe 150 km to the west have had a profound effect on sediment supply. This loss of sediment load is occurring as the Mississippi Delta is nearing the end of its natural 1000-yr life cycle, and has overwhelmed the ability of fragile wetlands, already in a state of delicate balance, to survive the combined effects of global sea-level rise and subsidence. Mitigation through creation of an extensive network of artificial diversions will slow the rate of delta deterioration but will not be able to rejuvenate a dying delta lobe.

J.D. Milliman and B.U. Haq (eds.), Sea-Level Rise and Coastal Subsidence, 281-311.

ELSEVIER Geomorphology 48 (2002) 233–243
www.elsevier.com/locate/geomorph

Sea-level rise and coastal marsh sustainability: geological and ecological factors in the Mississippi delta plain

Denise J. Reed *

Department of Geology and Geophysics, University of New Orleans, New Orleans, LA 70148, USA

Received 15 August 1998; received in revised form 30 August 2000; accepted 24 January 2002

Abstract

Chronostratigraphic approaches to coastal geomorphology frequently include consideration of salt marsh deposits as indicators of past sea-level positions. Continuous horizons of such deposits can be used to infer that salt marshes were keeping pace with local rates of relative sea-level rise (RSLR). Rates of past accumulation, estimated using dating techniques, are then used to hindcast the rate of sea-level rise in that area. Estimates of contemporary sea-level rise rates are often derived from tide gauge records. This approach allows identification of subdecadal variations in mean water level. Accumulation rates of both organic and inorganic sediments can also be derived at these time scales and studies from many coastal marshes demonstrate the episodic nature of inorganic sediment deposition. The frequency and spacing of these events does not necessarily coincide with periods of increased local sea level. In addition, short-term increases in sea level could result in marsh deterioration as soils become excessively waterlogged. A conceptual model of changes in geomorphic and ecological processes contributing to marsh sustainability during the Holocene has been developed for the Mississippi delta plain (MDP). The survival of some marshes in this area, despite high rates of subsidence, indicates that the combined effect of organic and inorganic accumulation processes can be adequate to sustain coastal marshes in the face of sea-level rise.

Keywords: Marsh sedimentation; Mississippi Delta Plain; Sea-level rise; Subsidence

---

COAST 2050: A NEW APPROACH TO RESTORATION OF LOUISIANA COASTAL WETLANDS

2004, Physical Geography, v. 25, p. 4-21.

Denise J. Reed
Department of Geology and Geophysics
University of New Orleans
New Orleans, Louisiana 70148

Lee Wilson
Lee Wilson and Associates
Box 931
Santa Fe, New Mexico 87501

Abstract: The loss of Louisiana's coastal wetlands continued at a rate of over 60 km^2 per year in the 1990s and continued losses of an additional 1295 km^2 are projected by 2050. The rapid rate of land loss is attributed to a complex combination of natural landscape dynamics and massive human alterations of deltaic and wetland hydrology. While the problem was recognized in the 1970s, concerted attempts at restoration did not begin until the 1990s. Initial efforts largely focused on addressing local problem areas and were often defensive in nature; that is they sought to prevent future losses rather than restoring any of the wetlands which had already converted to open water. In the late 1990s, a new plan was developed with a more systemic approach to restoration. The Coast 2050 plan embraces the problems at the ecosystem scale and seeks to restore essential processes rather than continued manipulation of wetland hydrology. Implementation of this plan in the 21st century will require detailed consideration of riverine and deltaic processes, ecosystem response to changes in those processes, and the socioeconomic implications of major re-plumbing of the Mississippi River Delta. [Key words: Mississippi River Delta, ecosystem restoration, wetlands, land loss.]

Estuaries Vol. 23, No. 4, p. 425–438 August 2000

Pattern and Process of Land Loss in the Mississippi Delta: A Spatial and Temporal Analysis of Wetland Habitat Change

JOHN W. DAY, JR.[1]
Department of Oceanography and Coastal Sciences
Coastal Ecology Institute
Louisiana State University
Baton Rouge, Louisiana 70803

GARY P. SHAFFER
Department of Biological Sciences
Southeastern Louisiana University
Hammond, Louisiana 70402-10736

LOUIS D. BRITSCH
U.S. Army Corps of Engineers
New Orleans District, Engineering Division
P. O. Box 60267
New Orleans, Louisiana 70160-0267

DENISE J. REED
Department of Geology
University of New Orleans
New Orleans, Louisiana 70148

SUZANNE R. HAWES
U.S. Army Corps of Engineers
New Orleans District, Planning Division
P. O. Box 60267
New Orleans, Louisiana 70160-0267

DONALD CAHOON
National Wetlands Research Center
U.S. Geological Survey
700 Cajundome Boulevard
Lafayette, Louisiana 70506

ABSTRACT: An earlier investigation (Turner 1997) concluded that most of the coastal wetland loss in Louisiana was caused by the effects of canal dredging, that loss was near zero in the absence of canals, and that land loss had decreased to near zero by the late 1990s. This analysis was based on a 15-min quadrangle (approximately 68,000 ha) scale that is too large to isolate processes responsible for small-scale wetland loss and too small to capture those responsible for large-scale loss. We conducted a further evaluation of the relationship between direct loss due to canal dredging and all other loss from 1933–1990 using a spatial scale of 4,100 ha that accurately captures local land-loss processes. Regressions of other wetland loss on canal area (i.e., direct loss) for the Birdfoot, Terrebonne, and Calcasieu basins were not significant. Positive relationships were found for the Breton ($r^2 = 0.675$), Barataria ($r^2 = 0.47$), and Mermentau ($r^2 = 0.35$) basins, indicating that the extent of canals is significantly related to wetland loss in these basins. A significant negative relationship ($r^2 = 0.36$) was found for the Atchafalaya coastal basin which had statistically lower loss rates than the other basins as a whole. The Atchafalaya area receives direct inflow of about one third of the Mississippi discharge. When the data were combined for all basins, 9.2% of the variation in other wetland loss was attributable to canals. All significant regressions intercepted the y-axis at positive loss values indicating that some loss occurred in the absence of canals. Wetland loss did not differ significantly from the coast inland or between marsh type. We agree with Turner that canals are an important agent in causing wetland loss in coastal Louisiana, but strongly disagree that they are responsible for the vast majority of this loss. We conclude that wetland loss in the Mississippi delta is an ongoing complex process involving several interacting factors and that efforts to create and restore Louisiana's coastal wetlands must emphasize riverine inputs of freshwater and sediments.

A new vision for New Orleans and the Mississippi delta: applying ecological economics and ecological engineering

Robert Costanza[1*], William J Mitsch[2], and John W Day Jr[3]

The restoration of New Orleans and the rest of the Mississippi delta after Hurricane Katrina can become another disaster waiting to happen, or it can become a model of sustainable development. Sea level is rising, precipitation patterns are changing, hurricane intensity is increasing, energy costs are predicted to soar, and the city is continuing to sink. Most of New Orleans is currently from 0.6 to 5 m (2–15 feet) below sea level. The conventional approach of simply rebuilding the levees and the city behind them will only delay the inevitable. If New Orleans, and the delta in which it is located, can develop and pursue a new paradigm, it could be a truly unique, sustainable, and desirable city, and an inspiration to people around the world. This paper discusses the underlying causes and implications of the Katrina disaster, basic goals for a sustainable redevelopment initiative, and seven principles necessary for a sustainable vision for the future of New Orleans and the Mississippi delta.

Front Ecol Environ 2006; 4(9): 465–472

2007, Science, v. 315, p. 1679 - 1684.

Restoration of the Mississippi Delta: Lessons from Hurricanes Katrina and Rita

John W. Day Jr.,[1*] Donald F. Boesch,[2] Ellis J. Clairain,[3] G. Paul Kemp,[4] Shirley B. Laska,[5] William J. Mitsch,[6] Kenneth Orth,[7] Hassan Mashriqui,[8] Denise J. Reed,[9] Leonard Shabman,[10] Charles A. Simenstad,[11] Bill J. Streever,[12] Robert R. Twilley,[1] Chester C. Watson,[13] John T. Wells,[14] Dennis F. Whigham[15]

Hurricanes Katrina and Rita showed the vulnerability of coastal communities and how human activities that caused deterioration of the Mississippi Deltaic Plain (MDP) exacerbated this vulnerability. The MDP formed by dynamic interactions between river and coast at various temporal and spatial scales, and human activity has reduced these interactions at all scales. Restoration efforts aim to re-establish this dynamic interaction, with emphasis on reconnecting the river to the deltaic plain. Science must guide MDP restoration, which will provide insights into delta restoration elsewhere and generally into coasts facing climate change in times of resource scarcity.