

Geology of the Westlake 7.5-Minute Quadrangle, LA

Louisiana Geological Survey

Introduction, Location, and Geologic Setting

The Westlake 7.5-minute quadrangle lies in the southwestern portion of the south Louisiana coastal plain (Figure 1), in the drainage basin of the Calcasieu River. The quadrangle lies at the northern edge of the Gulf Coast salt basin, near the southern edge of coast-parallel outcrop belts of terraced Pleistocene strata comprising Intermediate, Prairie, and Deweyville allogroups (Lissie and Beaumont alloformations, and Deweyville Allogroup undifferentiated, respectively). Its surface consists exclusively of Holocene and terraced Pleistocene strata (Figure 2) deposited by the Sabine, Red, and Calcasieu rivers. All these strata consist of terrigenous sediment with varying proportions of sand, silt, mud, and/or gravel.

Features developed on the surface of the Beaumont Alloformation comprise coastal ridges of potentially diverse origins (Figure 2); prominent coastal ridges within the study area appear to comprise relict natural levees of Pleistocene courses of possibly both the Red and Sabine rivers. The area is transected by the traces of growth faults reactivated since the late Pliocene by depositional loading induced by voluminous sedimentation accompanying continental deglaciation (Heinrich, 2005; McCulloh and Heinrich, 2012). The Lockport salt dome underlies part of the north-central Westlake quadrangle, but lacks obvious surface expression.

The units recognized and mapped in this investigation are summarized in Figures 3 and 4.

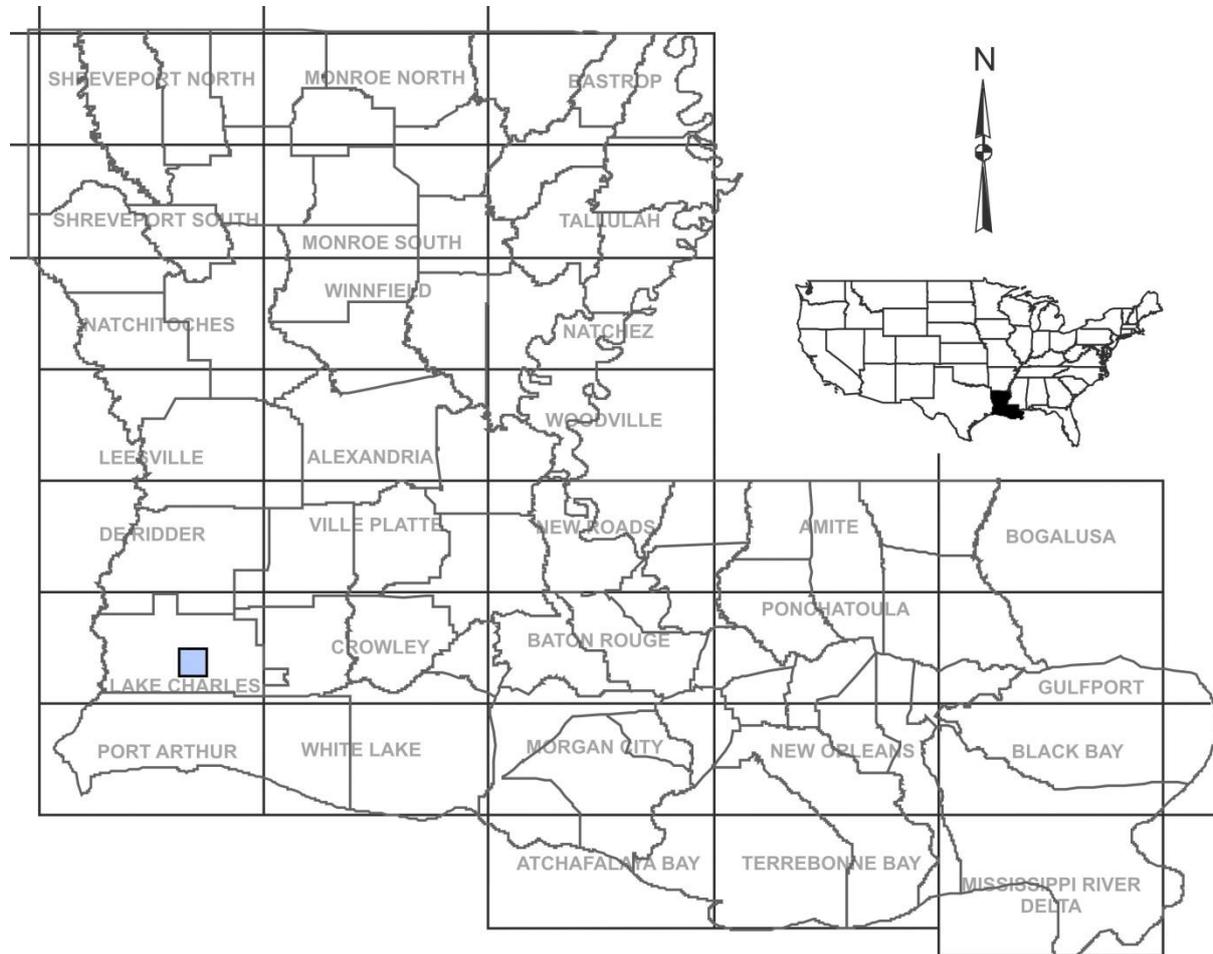
Previous Work

The Westlake quadrangle lies in the central portion of the eastern half of the Lake Charles 30 × 60 minute quadrangle, the surface geology of which was compiled at 1:100,000 scale by Heinrich et al. (2002) with STATEMAP support. Prior to this investigation, the basic framework of surface geology of the region encompassing the quadrangles was rendered at approximately 1:1,056,000 scale by Jones et al. (1954, their plate I) drawing in part upon unpublished work by Fisk (1948), and was summarized by Aronow (1986) for Calcasieu Parish. The regional framework later was updated at 1:1,100,000 scale in the compilation by Saucier and Snead (1989). Following the STATEMAP-supported compilation by Heinrich et al. (2002), Heinrich (2005) conducted further mapping of surface faults in this and surrounding areas. Groundwater conditions in the Chicot aquifer were detailed in numerous previous investigations conducted in the Lake Charles area, including Harder et al. (1967), Zack (1971), Haque (1984), and Milner and Fisher (2009).

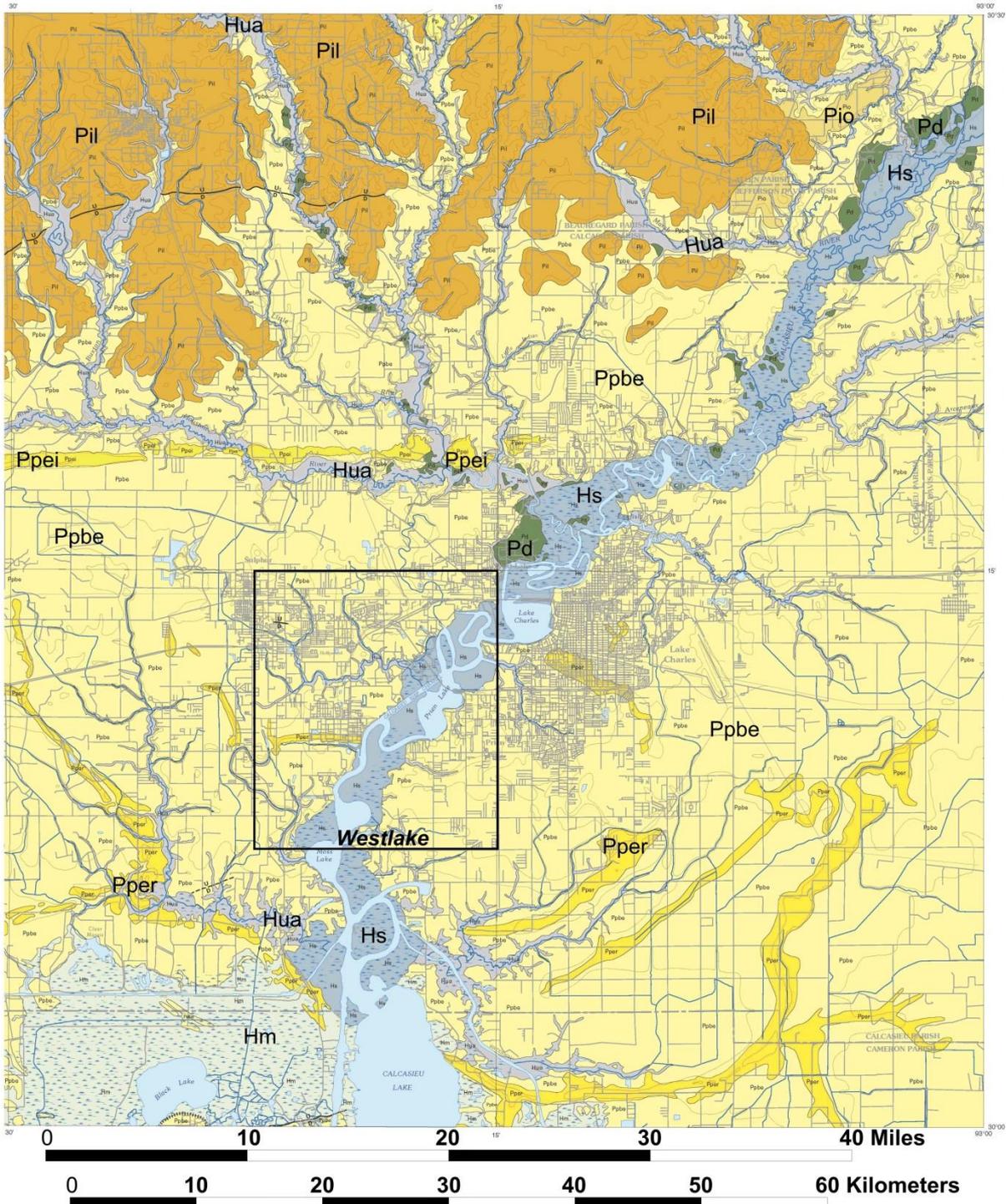
Methods

The investigators reviewed legacy information and made new interpretations consulting remotely sensed imagery (comprising aerial photography, LIDAR DEMs, and other sources) and soils databases published by the Natural Resources Conservation Service (NRCS) to develop a draft surface geology layer for the study area. Field work was conducted to test the subsoil with hand-operated probes and examine and sample the texture and composition of the surface-geologic map units. Field observations were then synthesized with the draft

surface geology to prepare an updated integrated surface geology layer for the 7.5-minute quadrangle.



1. Location of Westlake 7.5-minute quadrangle, southwestern Louisiana.



2. Surface geology of the area encompassing the Westlake 7.5-minute quadrangle (excerpted and adapted from Heinrich et al., 2002). (**Pil**, Lissie Alloformation, undifferentiated; **Pio**, Oakdale alloformation; **Ppbe**, Beaumont Alloformation; **Ppei**, Relict Pleistocene barrier ridge (Houston ridge); **Pper**, Relict Pleistocene ridges; **Pd**, Deweyville Allogroup, undifferentiated; **Hm**, Mermentau Alloformation; **Hs**, Small river deposits, undifferentiated; **Hua**, Holocene undifferentiated alluvium).

QUATERNARY SYSTEM

HOLOCENE

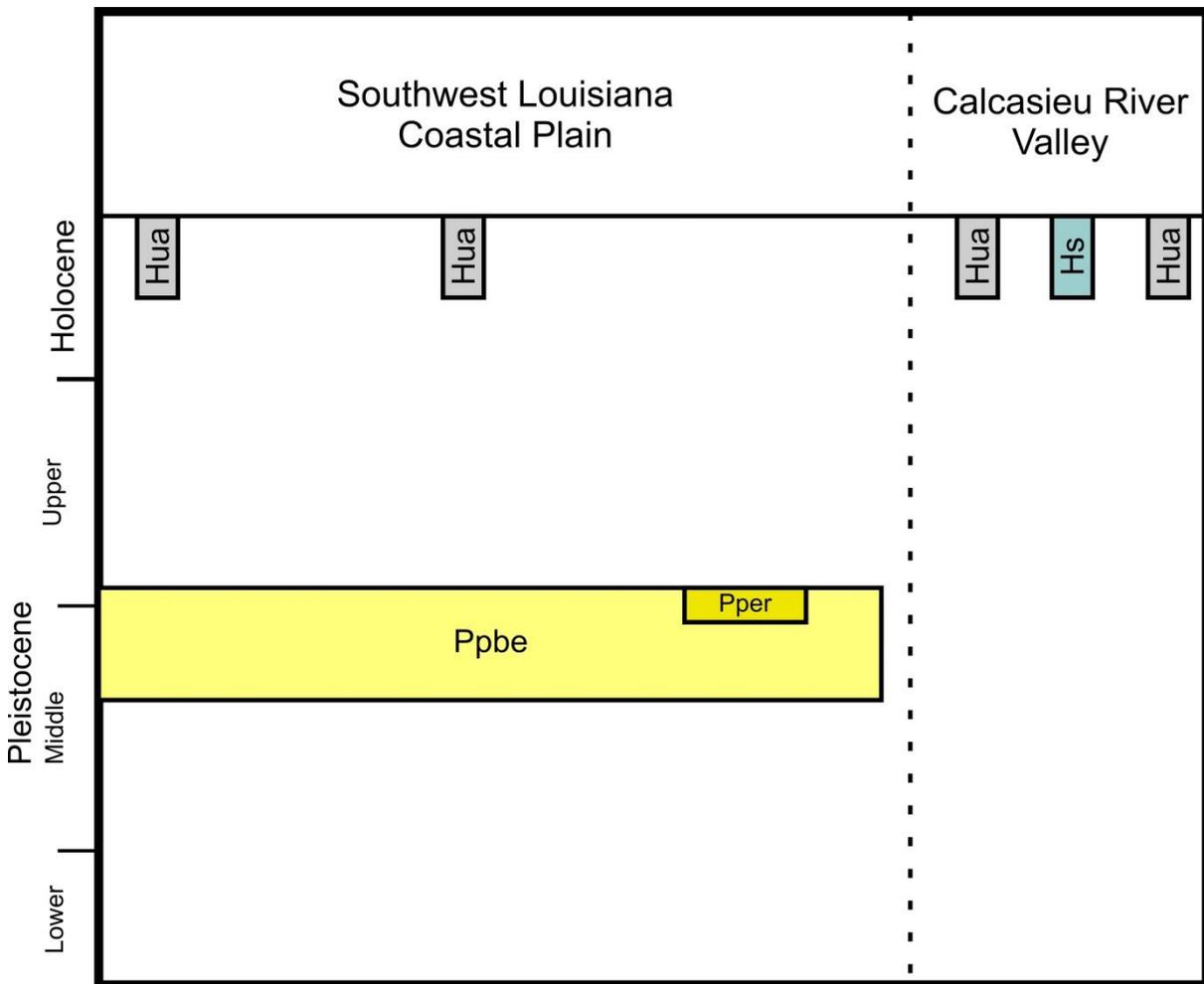
Hua Holocene undifferentiated alluvium
 Hs Small river deposits, undifferentiated

PLEISTOCENE

PRAIRIE ALLOGROUP

Pper Relict Pleistocene ridges
 Ppbe Beaumont Alloformation

3. Units mapped in the Westlake 7.5-minute quadrangle.



4. Correlation of strata mapped in the Westlake 7.5-minute quadrangle.

Allostratigraphic Approach to Pleistocene Unit Definitions

In the late 1980s the LGS had begun exploring the application of allostratigraphic concepts and nomenclature to the mapping of surface Plio–Pleistocene units (e.g., Autin, 1988). In Louisiana these units show a series of geomorphic attributes and preservation states

correlative with their relative ages, which eventually led LGS to conclude that allostratigraphy offers an effective if not essential approach to their delineation and classification (McCulloh et al., 2003). The Plio–Pleistocene strata for which allostratigraphic nomenclature presently has value to LGS all are situated updip of the hinge zone of northern Gulf basin subsidence, and show a clear spectrum of preservation from pristine younger strata to trace relicts and remnants of older strata persisting in the coastal outcrop belt and on high ridgetops in places updip of it. Allunit nomenclature has figured heavily in the STATEMAP-funded geologic mapping projects of the past two decades because Quaternary strata occupy approximately three-fourths of the surface of Louisiana. The preponderance of Quaternary strata in the present study area dictated continuation of this practice for this investigation.

Beaumont Alloformation (Prairie Allogroup)

The oldest unit exposed in the Westlake quadrangle is Beaumont Alloformation. It is an unconformity bounded stratigraphic unit that is separated from the underlying Lissie Formation Alloformation by a regional unconformity. This unconformity has been defined and mapped by Young et al. (2012). Except where cut by valleys formed during sea level lowstands of the last glacial epoch, the upper boundary of the Beaumont Alloformation within the study area consists of the surface of the coastal plain. The Beaumont alloformation consists of 30 to 60 m clay-rich sediments transected by dip-oriented fluvial sands sandy fluvial and deltaic-distributary channels. These sediments accumulated as short depositional episodes during multiple high-frequency glacio-eustatic sea-level fluctuations. The lower contact of the Beaumont Alloformation is a regionally extensive and laterally extensive flooding surface that was correlated with micropaleontological zones offshore and updip as far as possible. The lower contact of the Beaumont Alloformation is a regionally extensive and laterally extensive flooding surface that is correlated with micropaleontological zones offshore and updip as far as possible. This flooding surface is correlated northward along the bases of major channel sands to where it outcrops and the Beaumont alloformation onlaps on the surface Lissie Alloformation (Young et al., 2012). According to downdip correlations by Young et al. (2012), the Beaumont Alloformation accumulated after 0.6 Ma. The surface of Beaumont alloformation exhibits moderately well preserved relict depositional topography of the Sabine, Red, and other rivers and the Ingleside shoreline (Aronow 1986). To the north, its surface also includes an isolated segment of a coast-parallel, sandy beach ridge known as the Ingleside barrier/strandplain system (Barrilleaux, 1986).

Deweyville Allogroup

Within the Westlake quadrangle, the deposits of the Deweyville Allogroup are buried beneath the deposits of the Mermentau Alloformation and are not exposed at the surface. The Deweyville Allogroup consists of largely coarse-grained fluvial sediments that fill the bottom of the valley of Calcasieu Rivers and its tributaries. It consists of separate unconformity-bounded allostratigraphic units with terraces as their upper boundaries and fluvial entrenchment surfaces as their lower boundaries. The coarse-grained valley fills of the Deweyville Allogroup represents the abandonment and entrenchment of valleys within the Beaumont alluvial plains by river systems ca. 100 ka; and (b) multiple episodes of lateral migration, aggradation, and/or degradation within those valleys during the Marine Isotope Stages 4, 3, and 2. These fluvial systems were graded to shorelines at midshelf or farther south (Blum et al., 1995). The sediments of the Deweyville Alloformation is separated from

younger sediments by a flooding surface created by the accumulation of sediment during postglacial sea level rise and its burial by bayhead delta and swamp deposits.

Small River Deposits, Undifferentiated

Filling a valley cut by the Calcasieu River and its tributaries during the last glacial epoch, Marine Isotope Stage 2, are sediments mapped as undifferentiated small river deposits. These consist of a post-glacial valley-fill sequence that is 20–25 m (~65–80 ft) thick. This sedimentary sequence consists of a basal silty clay and clay estuarine and bay sediments that contain dip-oriented, sandy clay to sand delta-front deposits that are overlain by sand and sandy distributary deposits of a bayhead delta. Covering these sediments and forming the top of this sequence of Holocene sediments within this part of the Calcasieu River valley is a blanket of organic-rich mud that accumulated within brackish and cypress swamps (Nichols et al., 1996). The base of these sediments lies on the top of fluvial deposits and terraces of the Deweyville Allogroup, which fills the bottom of Calcasieu River valley. This contact is a regional unconformity known as the “Holocene–Pleistocene surface” (Milliken et al., 2008).

Summary of Results

The Pleistocene strata comprise units of the Prairie Allogroup, and consist of sediment deposited by the Sabine and Red rivers and by coastal processes. The Beaumont Alloformation, Prairie Allogroup, forms part of a coast-parallel belt of terraced Pleistocene strata. Coastal ridges developed on the surface of the Beaumont Alloformation comprise a ridges interpreted as fluvial in origin. Holocene strata comprise undifferentiated alluvium of the Calcasieu River and its tributaries.

Detailed mapping of coastal ridges on the surface of the Beaumont Alloformation should be applicable, in combination with subsurface data, to the prediction of sand and gravel potential.

Acknowledgments

The work described and summarized herein was supported by the National Cooperative Geologic Mapping Program, STATEMAP component, under cooperative agreement G14AC00222 with the U.S. Geological Survey.

References

- Aronow, S., 1986, Surface geology of Calcasieu Parish: Louisiana Geological Survey, Open-file report, no. 04–01 (prepared from unpublished report on file with U. S. Department of Agriculture, Natural Resource Conservation Service, Alexandria, Louisiana).
- Autin, W. J., 1988, Mapping alloformations in the Amite River, southeastern Louisiana: Geological Society of America Abstracts with Programs, v. 20, no. 4, p. 252.
- Barrilleaux, J., 1986, The geomorphology and Quaternary history of the Houston barrier segment of the Ingleside strandplain, Calcasieu Parish, Louisiana: M.S. thesis, University of Southwestern Louisiana, Lafayette.

- Blum, M. D., R. A. Morton, and J. M. Durbin, 1995, "Deweyville" terraces and deposits of the Texas Gulf Coastal Plain: Gulf Coast Association of Geological Societies Transactions, v. 45, p. 53–60.
- Fisk, H. N., 1948, Geological investigation of the lower Mermentau River basin and adjacent areas in coastal Louisiana: unpublished "Definite project report," Mermentau River, Louisiana, Appendix II, U.S. Army Corps of Engineers, Mississippi River Commission, Vicksburg.
- Haque, S. M., 1984, Ground-water quality in the Lake Charles area, Louisiana: Louisiana Geological Survey, Water resources series no. 2, 57 p.
- Harder, A. H., C. Kilburn, H. M. Whitman, and S. M. Rogers, 1967, Effects of ground-water withdrawals on water levels and salt-water encroachment in southwestern Louisiana: Louisiana Department of Conservation, Louisiana Geological Survey, Water resources bulletin no. 10, 56 p. plus plates.
- Heinrich, P. V., 2007, The Houston ridge: an ancient shoreline in Calcasieu Parish, Louisiana: Louisiana Geological Survey NewsInsights, v. 17, no. 1, p. 1–4.
- Heinrich, P. V., 2005, Distribution and origin of fault-line scarps of southwest Louisiana, USA: Gulf Coast Association of Geological Societies Transactions, v. 55, p. 284–293.
- Heinrich, P. V., J. Snead, and R. P. McCulloh (compilers), 2002, Lake Charles 30 × 60 Minute Geologic Quadrangle: Louisiana Geological Survey, Baton Rouge, Scale 1:100,000.
- Jones, P. H., A. N. Turcan, Jr., and H. E. Skibitzke, 1954, Geology and ground-water resources of southwestern Louisiana: Louisiana Department of Conservation, Louisiana Geological Survey, Geological bulletin no. 30, 285 p. plus plates.
- McCulloh, R. P., and P. V. Heinrich, 2012, Surface faults of the south Louisiana growth-fault province, in Cox, R. T., M. P. Tuttle, O. S. Boyd, and J. Locat, eds., Recent Advances in North American Paleoseismology and Neotectonics East of the Rockies: Geological Society of America Special Paper 493, p. 37–50, doi:10.1130/2012.2493(03).
- McCulloh, R. P., Heinrich, P. V., and Snead, J. I., 2003, Geology of the Ville Platte Quadrangle, Louisiana: Louisiana Geological Survey, Geological Pamphlet no. 14, 11 p.
- Milliken, K. T., J. B. Anderson, and A. B. Rodriguez, 2008, Tracking the Holocene evolution of Sabine Lake through the interplay of eustasy, antecedent topography, and sediment supply variations, Texas and Louisiana, USA, in Anderson, J. B., and A. B. Rodriguez, eds., Response of Upper Gulf Coast Estuaries to Holocene Climate Change and Sea-Level Rise: Geological Society of America Special Paper 443, p. 65–88, doi: 10.1130/2008.2443(05).
- Milner, L. R., and C. Fisher, 2009, Geological characterization of the Chicot/Atchafalaya aquifer region: southwest Louisiana: Louisiana Geological Survey, Water resources series no. 4, 39 p.

Nichol, S. L., R. Boyd, and S. Penland, 1996, Sequence stratigraphy of a coastal-plain incised valley estuary, Lake Calcasieu, Louisiana: *Journal of Sedimentary Research*, v. 66, no. 4, p. 847–857.

Saucier, R. T., and J. I. Snead (compilers), 1989, Quaternary geology of the Lower Mississippi Valley, *in* Morrison, R. B., ed., *Quaternary nonglacial geology: Conterminous U. S.*: Boulder, Colorado, Geological Society of America, *The Geology of North America*, v. K-2, Plate 6, scale 1:1,100,000.

Young, S. C., T. Ewing, S. Hamlin, E. Baker, and D. Lupin, 2012, Updating the hydrogeologic framework for the northern portion of the Gulf Coast Aquifer (final report): Texas Water Development Board, Austin, Texas, 283 p.

Zack, A. L., 1971, Ground-water pumpage and related effects, southwestern Louisiana, 1970 with a section on surface-water withdrawals: Louisiana Department of Conservation, Louisiana Geological Survey, Water resources pamphlet no. 27, 33 p. plus plates.