Geology of the Madisonville 7.5-Minute Quadrangle, LA

Louisiana Geological Survey

Introduction, Location, and Geologic Setting

The Madisonville 7.5-minute quadrangle lies in the "north shore" area of St. Tammany Parish (Figures 1, 2), at and immediately updip of the Toledo Bend Flexure (Lower Cretaceous shelf edge). The surface-geologic framework of this area in St. Tammany Parish was investigated and mapped by Cullinan (1969) at 1:62,500 scale, and the Holocene units in the southern half of the area later were differentiated at the same scale by May et al. (1984). The area to the north is underlain by the Pliocene Citronelle Formation (Upland allogroup), overlapped to the south by the Pleistocene Hammond alloformation (Prairie Allogroup). These Plio–Pleistocene strata are incised by deposits of Holocene age. The Hammond consists of deposits of the Mississippi and Pearl rivers and smaller coastal-plain streams, and its terrace surface exhibits constructional landforms of fluvial and deltaic origin in areas to the north and east of the proposed project area. These landforms, including oversized abandoned channels, appear to represent relict courses of the Pearl River formed during the Late Pleistocene. The Hammond also includes strike-parallel relict coastal ridges, which extend into the Madisonville quadrangle. In adjacent areas the Hammond is transected by active surface faults, aligned with the eastward extension of the Bancroft fault system of Murray (1961), which are discernible from their distinctive fault-line scarps.

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

Previous Work

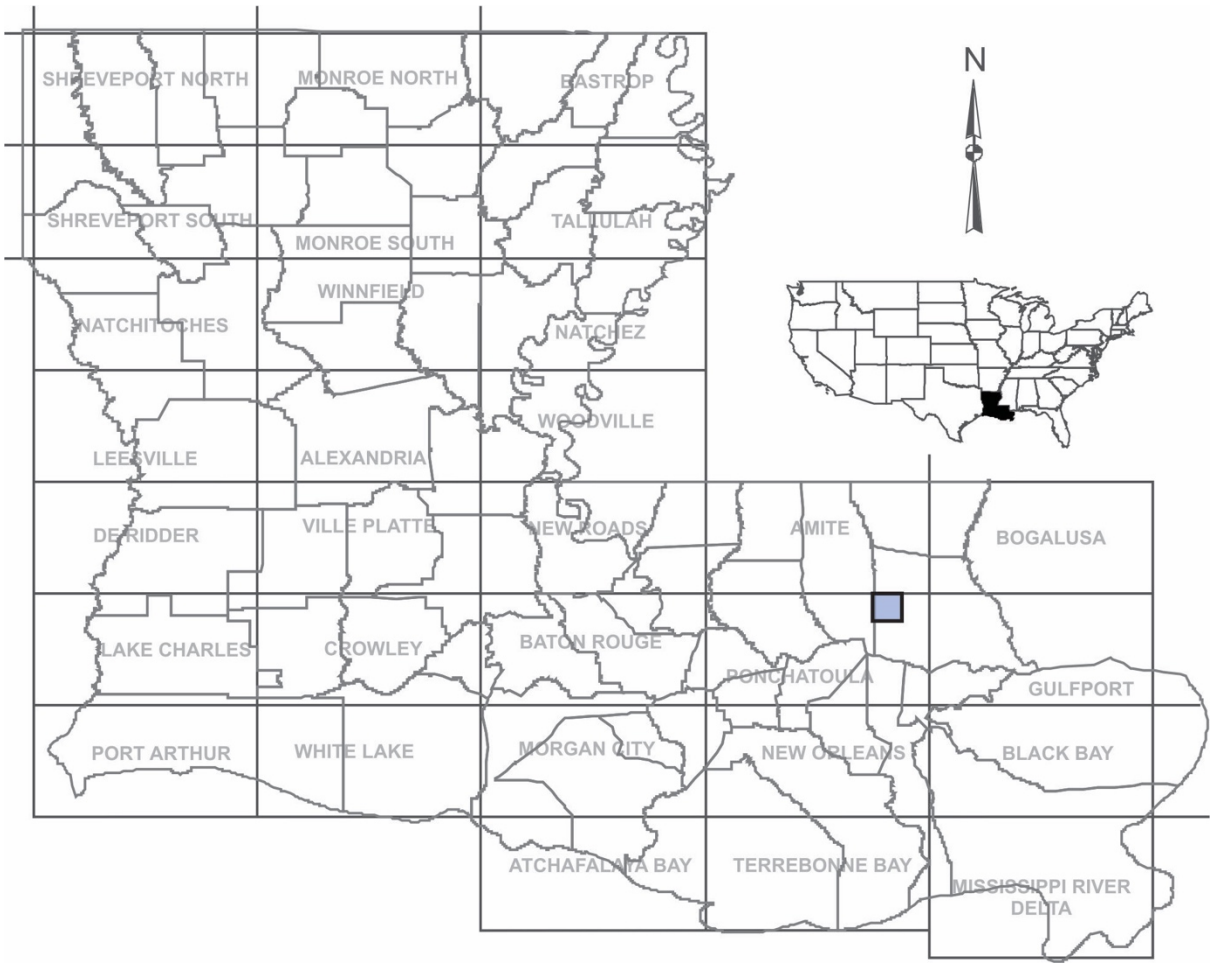
The Madisonville quadrangle lies in the northeastern portion of the Ponchatoula 30 × 60 minute quadrangle, the surface geology of which was compiled at 1:100,000 scale by McCulloh et al. (1997) with STATEMAP support, and later digitally recompiled and prepared as a Louisiana Geological Survey (LGS) lithograph (McCulloh et al., 2003a). The original 1996–1997 STATEMAP project involved compilations of the adjoining 30 × 60 minute quadrangles, also later prepared as lithographs: Amite (McCulloh and Heinrich, 2008; McCulloh et al., 2009), Bogalusa (Heinrich and McCulloh, 2007), and Gulfport (Heinrich et al., 2004). The project benefited from a drilling component by which the most problematic map-unit assignments were tested with a Giddings hydraulic probe. STATEMAP support also made possible new mapping of 7.5-minute quadrangles at 1:24,000 scale totaling eight sheets between fiscal years 2000 and 2002, and one sheet in fiscal year 2019 (Figures 1, 2).

The quadrangle is located in northern St. Tammany Parish. Self (1980, 1986) mapped the surface geology of the uplands of all of Louisiana's "Florida" parishes in southeastern Louisiana, though at 1:250,000 scale. Surface-geologic maps at 1:62,500 scale were prepared of Washington and St. Tammany Parishes by Cullinan (1969), and of St. Helena and Tangipahoa Parishes by Campbell (1972).

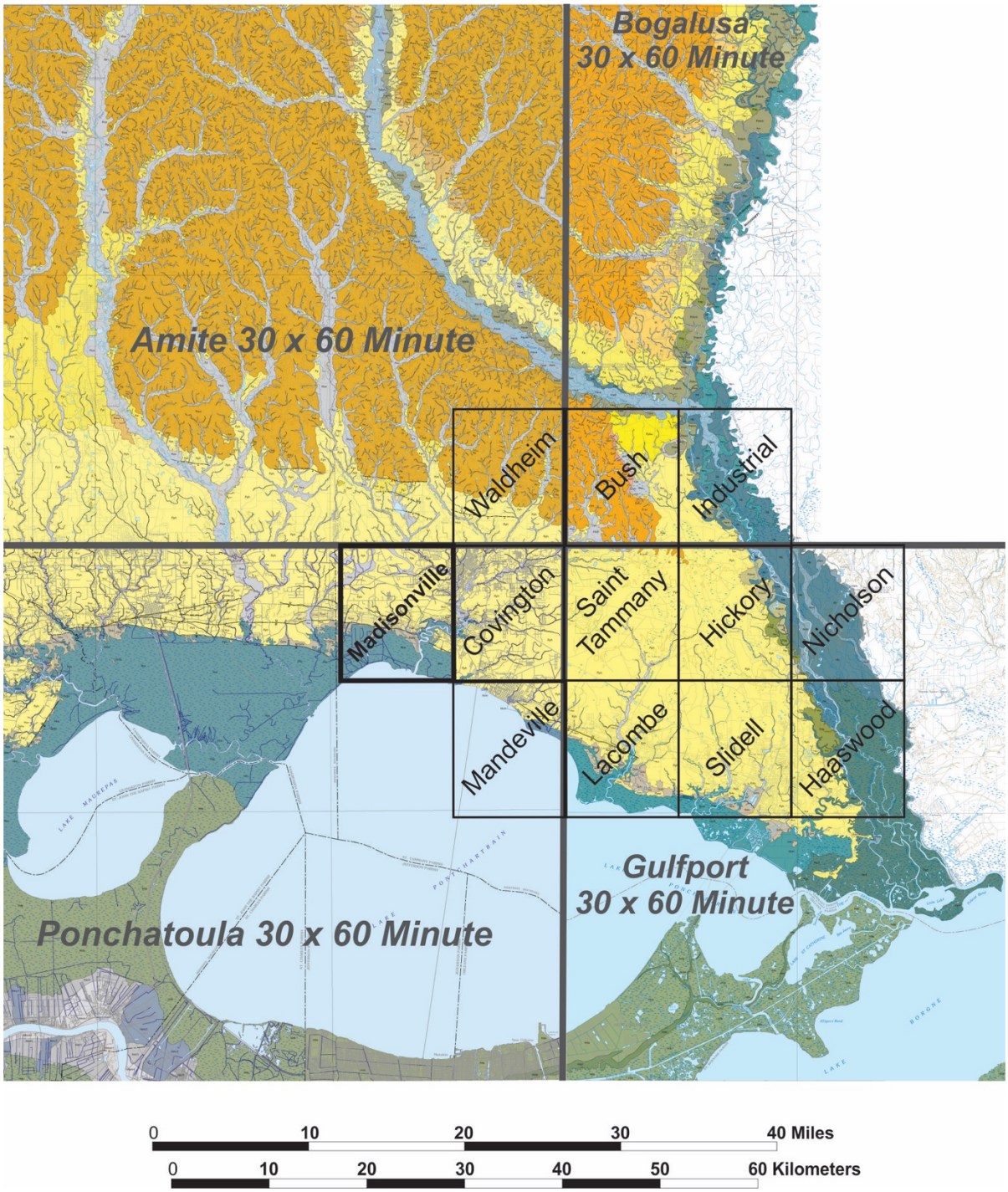
Tomaszewski et al. (2002) detailed groundwater conditions pertinent to the Southern Hills aquifer system, and Van Biersel and Milner (2010) summarized its distribution, recharge area, proportions of water-use categories, and pumpage rates.

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 access the subsoil in road- and drainage-associated excavations, to 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 Madisonville 7.5-minute quadrangle, southeastern Louisiana.



2. Surface geology of the area encompassing Madisonville 7.5-minute quadrangle, north shore area (mosaic of McCulloh et al., 2003a, 2009; Heinrich and McCulloh, 2007; and Heinrich et al., 2004). Previously mapped 7.5-minute quadrangles are outlined in black. The larger Holocene alluvial and deltaic plains (gray and green) lie to the south (Mississippi River) and east (Pearl River) of older Pleistocene (yellow, and green) to Pliocene (orange) sediment of the flanking uplands.

QUATERNARY SYSTEM

HOLOCENE

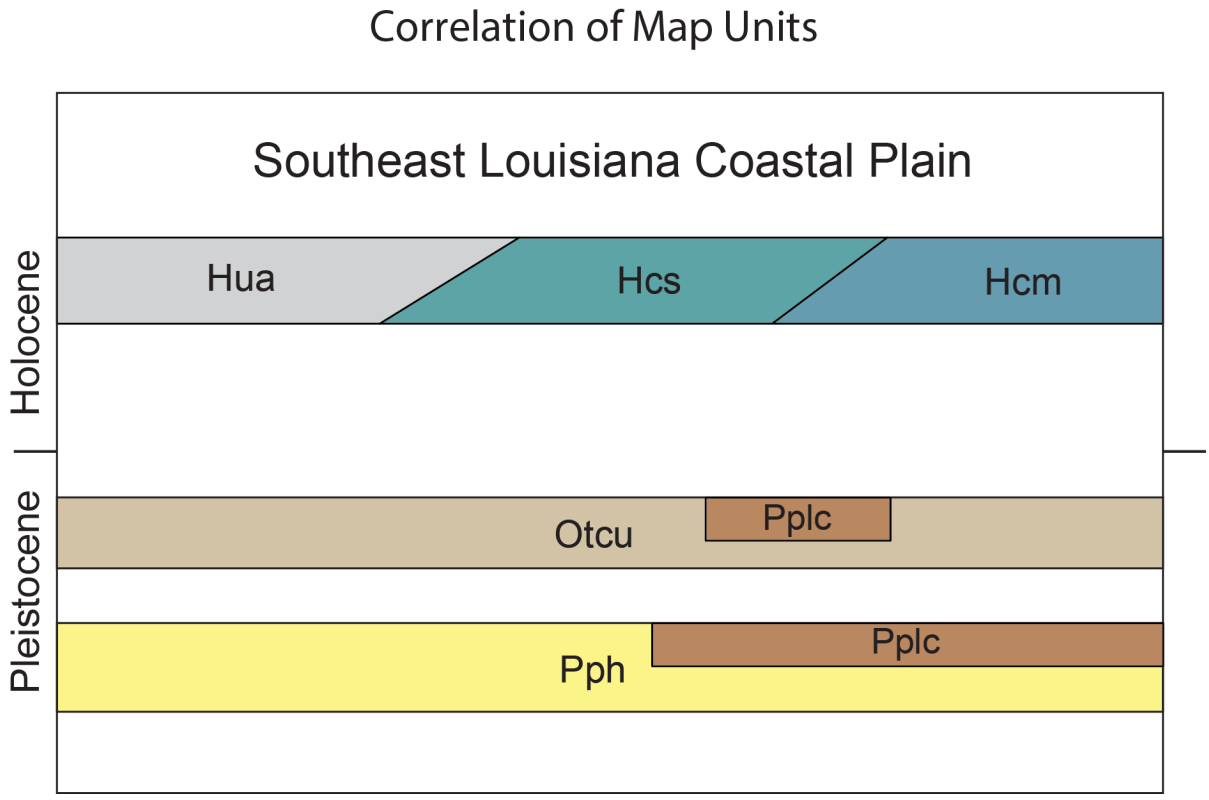
Hua Holocene undifferentiated alluvium
Hcs Holocene coastal swamp
Hcm Holocene coastal marsh

PLEISTOCENE

QUATERNARY UNDIFFERENTIATED
Qctu Undifferentiated low coastal terrace
Pplc Relict Pleistocene coastal ridges

PRAIRIE ALLOGROUP
Pph Hammond alloformation
Pplc Pleistocene coastal ridges

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



4. Correlation of strata mapped in the Madisonville 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., 2003b). 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. Allounit 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 surface of the Madisonville quadrangle consists exclusively of Quaternary strata, which dictated a continuation of this practice for this investigation.

Prairie Allogroup, undifferentiated (Pleistocene)

The Prairie Allogroup is a collection of late Pleistocene depositional sequences of alloformation rank (Autin et al., 1991; Heinrich, 2006). The sediments of the Prairie Allogroup accumulated within a diverse suite of coastal-plain settings, i.e., fluvial (meander-belt and backswamp), colluvial, possibly eolian, estuarine, deltaic, and shallow-marine environments. These largely fine-grained sediments accumulated over a considerable part of the late Pleistocene (Sangamon to Wisconsin) (Autin et al., 1991; Otvos, 2005; McCulloh et al., 2003a; Heinrich, 2006).

The surface of the Prairie Allogroup forms a coastal terrace along the northwest coast of the Gulf of Mexico from a point about 110 km (~70 mi) south of the Rio Grande within Mexico over to at least Mobile Bay, Alabama. This surface is the lowest continuous terrace lying above Holocene coastal and flood plains. This relatively undissected terrace exhibits constructional topography that is more poorly preserved than exhibited by terraces of the Deweyville Allogroup and lacking on older Pleistocene surfaces. It comprises multiple stratigraphic units of alloformation rank (Saucier and Snead, 1989; Autin et al., 1991; Dubar et al., 1991; Winker 1990).

Hammond alloformation, Prairie Allogroup (Pleistocene)

Within the Florida Parishes, the youngest and most extensive surficial unit is the Hammond alloformation of the Prairie Allogroup (Heinrich, 2006; McCulloh et al., 2009). Its name is derived from Hammond, Louisiana, and the Hammond terrace of Matson (1916). It is an allostratigraphic unit that forms part of the Prairie Allogroup. The surface of the Hammond alloformation is a well preserved coast-parallel terrace that is 16–40 km (10–25 mi) wide and extends from the eastern valley wall of the Mississippi River alluvial valley eastward across the Florida Parishes and the Pearl River into Mississippi. It is the lowest and best preserved of the Pleistocene terraces found between the Mississippi and Pearl rivers. In the Florida Parishes it exhibits moderately to poorly preserved relict constructional landforms. These landforms include relict river courses, meander loops, ridge-and-swale topography, coastal ridges, and beach ridges. In some areas, they include valley walls and flood plains of entrenched valleys. Overall, the surface of the Hammond alloformation consists of a series merged alluvial cones that abruptly flatten out into a broad coastal plain.

The surface of the Hammond alloformation is a well preserved, very gently gulfward (south) sloping coast-parrallel terrace. This surface drops in elevation from about 11 m above sea level in the northern Madisonville 7.5-minute quadrangle to about 7 m above sea level along the northern edge of the belt of relict coastal ridges. The slope of the surface of the Hammond alloformation abruptly changes from 0.03 to 0.01 percent within the northern part of this quadrangle.

The southern edge of the coast-parrallel terrace that forms the surface of the Hammond alloformation consists a belt of relict coastal ridges. This belt is about 0.9 to 1.2 km wide and extends east across the entire width of the Madisonville 7.5-minute quadrangle and a couple of hundred meters into the adjacent Covington 7.5-minute quadrangle. The crest of individual ridges become progressively lower gulfward towards the southern edge of surface of the Hammond alloformation.

Outcrops of the Hammond alloformation are quite rare within both the Covington and Madisonville 7.5-minute quadrangles. Those outcrops found consisted of the banks of drainage ditches and burrow pits and ephemeral excavation storm and wastewater infrastructure. The sediment exposed in such outcrops typically consisted of either brownish white light orangish brown, and light orangish red fine sandy clay, fine sandy mud, and muddy fine sand and light brownish white and light orangish white fine to medium grained sandy mud. An abandoned burrow pit situated in one of the relict coastal ridges exposed light gray-brown muddy fine-grained sand with mottling of orange streaks and stains.

Information concerning the age of the Hammond alloformation in the Madisonville 7.5-minute quadrangle is lacking. However, optical luminescence dates from the Baton Rouge and Denham Springs areas indicate that the Hammond alloformation is a mixture of sediments that accumulated during Marine Isotope Stages 5 and 3 and postdates Marine Isotope Stage 7 (Shen et al., 2012, 2016).

Quaternary undifferentiated

Lying below the level of the coast-parrallel terrace underlain by the Hammond alloformation is a flat-lying surface, informally mapped as the "undifferentiated low coastal terrace." This surface, which is almost completely onlapped by coastal swmap and marsh, ranges in elevation from sea level to about 1.5 m above sea level. It is separated from the topographically higher and older coast-parrallel terrace by a prominent scarp. The undifferentiated low coastal terrace is underlain by poorly consolidated, friable, gray-brown silt and very fine sand showing weak soil development. The partially buried nature of this surface, lack of subsurface data, and limited areal extent does not permit correlation of this stratigrahic unit and associated surface. Two relict Pleistocene coastal ridges are associated with this unit. The sediments underlying one of these ridges, Milton Island, consist of very deeply weathered, iron stained, medium and fine-grained sands consistent with a Late Pleistoocene beach ridge.

Holocene deposits

Holocene undifferentiated alluvium

The Holocene sediments mapped in the Madisonville 7.5-minute quadrangle along courses of upland waterways consist of undifferentiated unconsolidated alluvial deposits filling river and stream valleys of the Tchefuncte River basin. These deposits of upland rivers, streams, and creeks have not been studied in detail and are poorly known. The textures of their sediments vary greatly from gravelly sand to either sandy mud or silty mud. Typically, the amount of coarse-grained sediments present directly reflects the texture of the local "bedrock."

Holocene coastal swamp

gray to black clays of high organic content and thick peat beds, underlying freshwater marsh and swamp.

Holocene coastal marsh

gray to black, fine-grained, underconsolidated sediments with high organic content and peat beds, underlying coastal marsh.

Summary of Results

The surface of the Madisonville quadrangle comprises strata of the Pleistocene stratigraphic units of the Prairie Allogroup consisting of sediment deposited by coastal rivers and streams. The Hammond alloformation of the Prairie Allogroup forms part of a coast-parallel belt of terraced Pleistocene strata. Holocene strata comprise alluvium and backswamp deposits of the Tchefuncte River and its tributaries sediments underlying coastal marsh and swmaps.

The 1:24,000-scale surface-geologic map of Madisonville quadrangle provides basic geologic data of potential value to the conduct of fill-mining activities (Heinrich and McCulloh, 1999; U.S. Geological Survey, 2011). The map also should serve efforts at protection of the Southern Hills aquifer system in the Madisonville–Covington area.

Acknowledgments

The work described and summarized herein was supported by the National Cooperative Geologic Mapping Program, STATEMAP component, under cooperative agreement G20AC00239 with the U.S. Geological Survey.

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