

Geology of the French Settlement 7.5-Minute Quadrangle, LA

Louisiana Geological Survey

Introduction, Location, and Geologic Setting

The French Settlement 7.5-minute quadrangle lies east of the Holocene Mississippi River flood plain in the southeastern portion of the south Louisiana coastal plain (Figures 1, 2), in the drainage basin of the Amite River. The axis of the deep-subsurface lower Cretaceous shelf edge (Toledo Bend flexure), which trends west-northwest to east-southeast, lies approximately 28 km (17.4 mi) to the north of the study area. The surface of French Settlement quadrangle comprises strata of the Pleistocene Hammond alloformation, Prairie Allogroup, characterized by a preserved depositional surface with indistinct constructional topography. Late Pleistocene Peoria Loess thinner than 1 m (3 ft) in most places, but ranging up to 3 m (10 ft) thick along the south half of the quadrangle's western edge, covers the Hammond, and Holocene deposits incise it. The latter comprises undifferentiated alluvium of the Amite River and its tributaries and, in the quadrangle's southeastern portion, Holocene coastal swamp deposits fringing the proximal edge of the Holocene Mississippi River delta plain.

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

Previous Work

The French Settlement quadrangle is in the northwestern 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 prepared as a Louisiana Geological Survey (LGS) lithograph (McCulloh et al., 2003a). The original 1996–1997 STATEMAP project included compilation of the Amite 30 × 60 minute geologic quadrangle, adjoining Ponchatoula quadrangle on the north, also later prepared as a lithograph (McCulloh et al., 2009). It benefited from a drilling component by which the most problematic map-unit assignments were tested with a total of 15 holes drilled with a Giddings hydraulic probe.

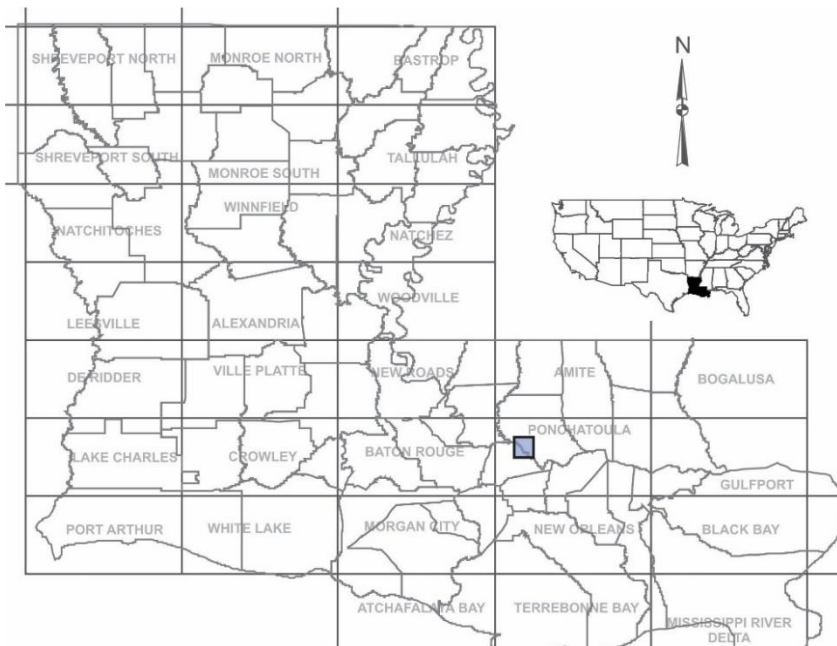
The quadrangle covers portions of two parishes (Figure 1), Ascension and Livingston. Self (1980, 1986) mapped the surface geology of the uplands of all of Louisiana's "Florida" parishes in southeastern Louisiana, though at 1:250,000 scale. Autin and McCulloh (1991) mapped the surface geology of East Baton Rouge Parish, immediately northwest of the quadrangle, at 1:24,000 scale.

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.

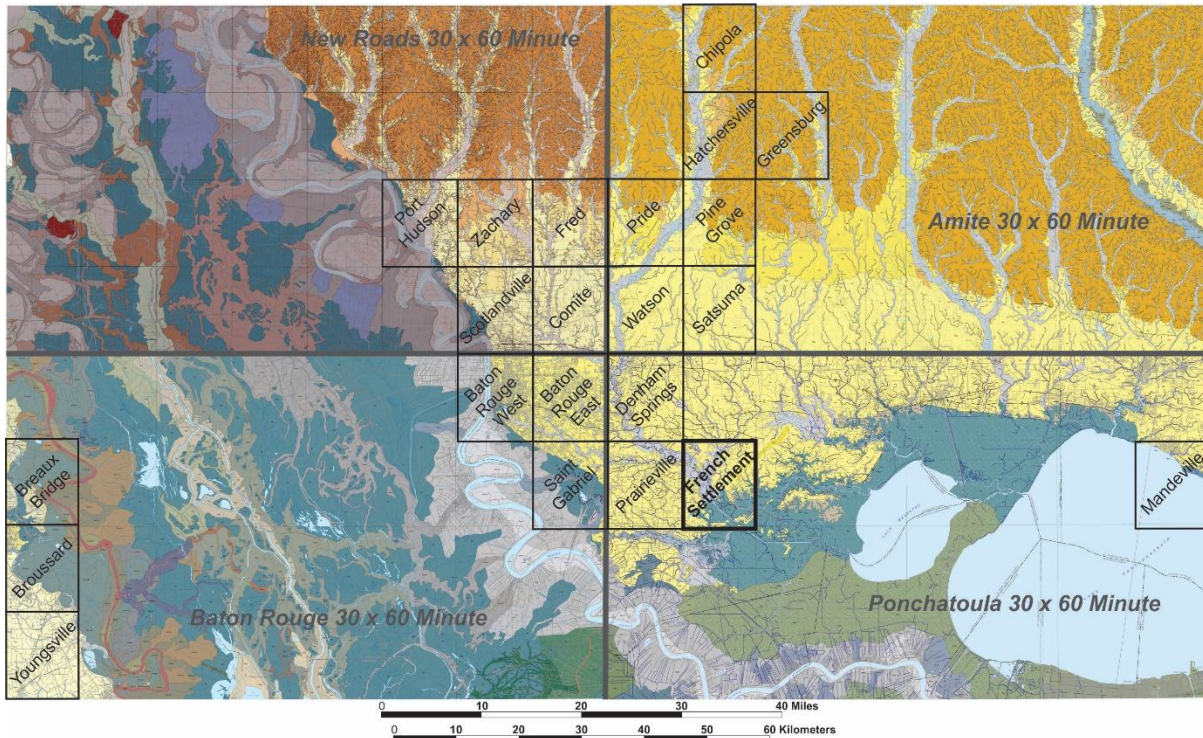
Methods

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 examine and sample the subsoil in natural and artificial exposures and test it in places with hand-operated probes, to determine and characterize 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 French Settlement 7.5-minute quadrangle, southeastern Louisiana.



2. Surface geology of the greater Baton Rouge area and environs (mosaic of Heinrich and Autin, 2000; Heinrich and McCulloh, 2007; and McCulloh et al., 2003a, 2009). French Settlement 7.5-minute quadrangle is shown in relation to other mapped quadrangles. Port Hudson, Scotlandville, Baton Rouge West, and Saint Gabriel quadrangles span the boundary

between the Holocene Mississippi alluvial plain and Pliocene (orange) and Pleistocene (yellow to pale orange) sediment of the flanking uplands.

QUATERNARY SYSTEM

HOLOCENE

- Hua Holocene undifferentiated alluvium
- Hcs Holocene coastal swamp and marsh

PLEISTOCENE

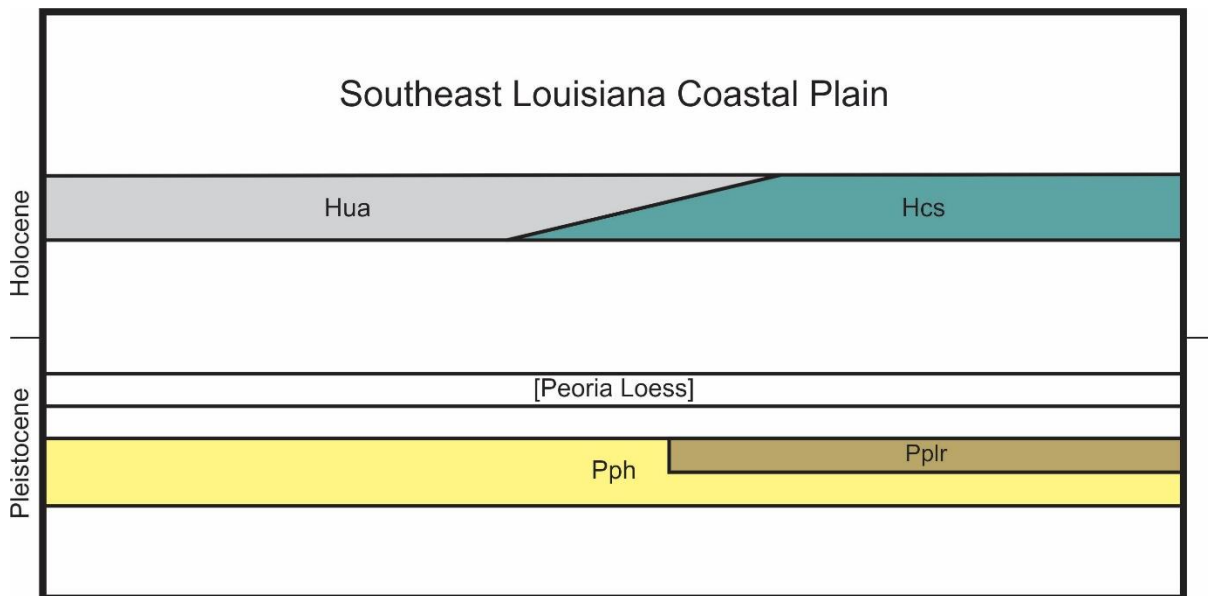
LOESS

- [pattern] Peoria Loess

PRAIRIE ALLOGROUP

- Pplr Relict Pleistocene ridges
- Pph Hammond alloformation

3. Units mapped in the French Settlement 7.5-minute quadrangle.



4. Correlation of strata mapped in the French Settlement 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. 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 surface of the French Settlement quadrangle consists exclusively of Quaternary strata, which dictated a continuation of this practice for this investigation.

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 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 coast-parallel 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. North of French Settlement quadrangle in the adjoining Walker quadrangle, faulting has displaced the surface of the Hammond alloformation, creating numerous fault-line scarps.

Within the French Settlement 7.5-minute quadrangle, the surface of the Hammond alloformation is well preserved and exhibits relict constructional topography. In the quadrangle, the Hammond exhibits two surfaces. The oldest and topographically highest is a coast-parallel terrace, which is moderately well dissected by main courses and tributaries of the modern Amite River. The terrace surface is still well preserved and exhibits relict constructional topography. The coast-parallel terrace is entrenched by paleovalleys of a course of the late Pleistocene Amite River and of one of its tributaries, which have a confluence in the quadrangle's northern portion. The floors of these paleovalleys are relatively undissected and exhibit well-preserved, relict fluvial landforms. The edges of the paleovalleys show relief up to approximately 4 m (13 ft) and are indicated on the geologic map with an escarpment symbol.

Information concerning the age of the Hammond alloformation in the quadrangle is locally lacking. However, optical luminescence dates and estimated fault slip rates from the Baton Rouge and Denham Springs areas indicate that the regional coast-parallel terrace dates to Marine Isotope Stage 5 and the Amite River paleovalley dates to Marine Isotope Stage 3 (Shen et al., 2012, 2016).

Peoria Loess (Pleistocene)

In the French Settlement 7.5-minute quadrangle, a blanket 1–3 m thick of relatively homogeneous, seemingly nonstratified, unconsolidated, well-sorted silt blankets the Pleistocene Hammond alloformation. This surficial layer of well-sorted silt, which is called “loess,” is recognizable by its unusually massive nature, uniformly tan to brown color, and

extraordinary ability to form and maintain vertical slopes or cliffs (Miller et al., 1985; Pye and Johnson, 1988; McCraw and Autin, 1989; and Saucier, 1994). It is mostly less than 1 m (3 ft) thick, but ranges up to 3 m (10 ft) thick along the south half of the quadrangle's western edge (Miller, 1983).

Loess is eolian sediment that accumulated during times of near-maximum to early-waning glaciation. During such periods, seasonally prevailing, strong, north and northwest winds deflated large amounts of silt from recently deposited and unvegetated glacial outwash that accumulated within glacial valley trains. These seasonal winds then transported the material for tens to hundreds of kilometers (tens to hundreds of miles) to the east and south. Eventually, this deflated silt fell out of suspension and incrementally accumulated within adjacent uplands as a drape over either preexisting terraces or dissected, hilly landscape. The greatest amount and relatively coarsest of the silt accumulated closest to the source areas (Miller et al., 1985; Pye and Johnson, 1988; McCraw and Autin, 1989; and Saucier, 1994).

Only one loess blanket, Peoria Loess, occurs within the French Settlement 7.5-minute quadrangle. It thins eastward to the point that it is completely mixed into the underlying sediment as part of the modern soil east of the Amite River. Numerous radiocarbon, thermoluminescence, and optical luminescence dates and other lines of evidence have been used to determine the age of the Peoria Loess. It has been found to be unquestionably of Late Wisconsin age, between 22,000 and 12,500 years BP, and consistent with the age of known meltwater valley trains (Miller et al., 1985; Pye and Johnson, 1988; McCraw and Autin, 1989; and Saucier, 1994).

Holocene deposits

Mississippi River delta plain

The southeastern portion of French Settlement 7.5-minute quadrangle overlaps the northern edge of the Holocene Mississippi River delta plain, consisting of Holocene coastal swamp and marsh (**Hcs**) deposits at the surface. Within this quadrangle, log descriptions for a set of 29 geotechnical borings, LA DOTD (2016), for the Louisiana Highway 16 Amite River Bridge near French Settlement provide information about the sediments that fill a paleovalley underlying the modern (Holocene) coastal swamp and marsh. In these borings, the upper 6–9 m (20–30 ft) of sediments underlying the surface of the modern swamp largely consists of soft, greenish gray, light gray, dark gray, or rarely black, organic-rich clay and peat. Many of these sediments contain roots and wood fragments. Adjacent to the modern Amite River channel, these deposits include isolated beds of very to medium stiff, brown, light gray or gray clay, silty clay, or sandy clay that in many places contain organic matter and roots. These beds appear to thin and eventually pinch out within swamp and marsh sediments. In the center of the paleovalley, these deposits overlie about 15 m (50 ft) of Amite River alluvium which consists largely of beds of medium stiff sandy clay and light gray to greenish gray silty sand and sand. Outside of the central paleovalley, the swamp and marsh deposits lie directly on weathered sediments of the Hammond alloformation.

Outside of the French Settlement 7.5-minute quadrangle, soil boring logs in URS Corporation (2013) show that these sediments change in character. Laterally, they grade southward into very soft, gray to black, organic-rich clay and peat overlying a basal layer of very soft, greenish gray to light gray, organic-rich silty clay. The basal greenish gray to light gray silty clay lies unconformably upon the surface of weathered and overconsolidated Late Pleistocene sediments.

Upland streams

Streams are incised into Pleistocene uplands east of the Mississippi River flood plain, and comprise the Amite River and its tributaries. The alluvium mapped along these courses (**Hua**) is undifferentiated. The textures of these 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.”

Summary of Results

The surface of the French Settlement quadrangle comprises Holocene undifferentiated alluvium of the Amite River and its tributaries, the proximal Mississippi River delta plain, and the Pleistocene Hammond alloformation, Prairie Allogroup, consisting of sediment deposited by the Mississippi and Amite Rivers and by coastal processes. The Hammond forms part of a coast-parallel belt of terraced Pleistocene strata, and is covered by late Pleistocene Peoria Loess up to 3 m thick.

The 1:24,000-scale surface-geologic map of French Settlement quadrangle provides basic geologic data of potential value to planners in the southeastern greater Baton Rouge area. The map also may have utility in guiding sand and gravel exploration in the Hammond, from which they have been produced in an area directly to the north (U.S. Geological Survey, 2011), and in efforts at protection of the underlying Southern Hills aquifer system.

Acknowledgments

The work described and summarized herein was supported by the National Cooperative Geologic Mapping Program, STATEMAP component, under cooperative agreement G19AC00223 with the U.S. Geological Survey.

Gavin Gautreau, Louisiana Transportation Research Center, provided logs of soil borings drilled for the Louisiana Highway 16 Amite River Bridge near French Settlement, on file in the archives of the Louisiana Department of Transportation & Development (LA DOTD, 2016).

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