Generalized Geology of Louisiana

Prepared by the Louisiana Geological Survey staff, 2008

The surface of Louisiana is underlain by geologically young sedimentary sequences that were deposited in or adjacent to rivers and deltas in a coastal-plain setting. These deposits and those in other states flanking the Mississippi valley indicate that a major river system corresponding to the Mississippi has persisted at least since the Gulf of Mexico began to form by the separation of North America from South America. In general, the entire suite of fluvial, deltaic, and coastal deposits has advanced farther into the Gulf through time, and continues now to fill it with sediment. Evaporation of the shallow sea that was the early Gulf of Mexico produced thick salt deposits, now deeply buried, from which salt spines intrude the overlying strata and form near-surface domes.

Most surface exposures in Louisiana consist of Quaternary (Pleistocene and Holocene) sediment. Holocene deposits, including **alluvium** of the Mississippi, Red, Ouachita, and other rivers and smaller tributaries, and **coastal marsh** deposits, occupy about 55% of the surface. The alluvium consists of sandy and gravelly channel deposits mantled by sandy to muddy natural levee deposits, with organic-rich muddy backswamp deposits in between; coastal marsh deposits are chiefly mud and organic matter. Approximately 20% of the state's surface is occupied by **Pleistocene terraces**; the deposits associated with them also consist of sand, gravel, and mud, but underlie raised, flat surfaces with varying degrees of tilt and dissection depending on their relative ages. These surfaces are remnants of pre-existing flood plains, and form both trends along the major rivers in north Louisiana and coast-parallel belts in southern Louisiana. They were raised as the coastal plain tilted in response to downwarping of the crustal floor of the Gulf of Mexico—the result of the deposition of voluminous deltaic sediment ever farther into the Gulf through time.

During glacial episodes in the Pleistocene, sea level dropped, shorelines moved seaward, and the Mississippi River carried an increased sediment load. When this happened the Mississippi switched from a meandering to a braided regime, rivers flowing into the Gulf of Mexico could deposit their sediment farther out than before (or since), and outwash deposits of sand, gravel, and silt, now preserved as **terraced braided-stream deposits**, were deposited in the lower Mississippi valley. The remnants of these late Pleistocene braided-stream deposits occur in eastern north and central Louisiana along the western edge of the Mississippi River flood plain and, like the other Pleistocene terraces, form flat surfaces that rise above it. The large quantity of glacial outwash in the Mississippi River valley at this time was the source of loess, the silt fraction entrained, suspended, and redeposited by strong winds. Loess deposits up to several meters thick covered and remain preserved along large areas flanking the valley.

Most of the rest of the state's surface (about 25%) comprises strata of Tertiary age, principally on the Sabine uplift (a large structure centered on southwestern Caddo and northwestern De Soto parishes, in northwestern Louisiana, and in adjacent portions of Texas) and in the north Louisiana salt-dome basin. Within this area of Tertiary exposures, upper Cretaceous rocks also are present in a few small exposures on the tops of salt domes that have surface expression.

Tertiary strata range in age from Paleocene (Wilcox Group) to Pliocene (Willis and Citronelle formations, Upland allogroup). Strata of the Wilcox, Claiborne, and Fleming groups occupy the largest area: Wilcox exposures predominate on the Sabine uplift (whereas farther southeast in central Louisiana equivalent Wilcox beds lie as deep as 8,000 ft below sea level); Claiborne Group exposures predominate in the north Louisiana salt-dome basin; and Fleming Group exposures predominate on the southeastern flank of the Sabine uplift. **Wilcox** and **Claiborne** strata consist of sandstone and mudstone deposited in deltaic and shallow marine settings. In Louisiana, the **Jackson** and **Vicksburg** strata are primarily mudstone, relatively thin, and exposed in a narrow belt southeast of the Sabine uplift and the north Louisiana salt-dome basin. In the next younger outcrop belt to the southeast lies the **Catahoula Formation**, consisting of sandstone, siltstone, and mudstone deposited by rivers, with some material derived from the alteration of volcanic ash blown to Louisiana from the west. Much of the sandstone is hard, and the Catahoula outcrop belt is marked by the most resistant and prominent landscape element in the state. The overlying **Fleming Group** also consists of sandstone, siltstone, and mudstone deposited mostly by rivers, with some volcanic-ash derivatives. Within the past 15 years, Fleming Group strata have yielded a diverse Miocene vertebrate fauna from localities both in west-central Louisiana and east of the Mississippi River in the Feliciana parishes. Pliocene strata consist of sandstone, gravelly sandstone, and mudstone of the **Upland allogroup** in west-central Louisiana (**Willis Formation**) and in the Florida parishes of southeastern Louisiana (**Citronelle Formation**); these latest-Tertiary strata occupy roughly 5% of the state's surface.

The processes that created the fluvial and deltaic sedimentary sequences that comprise the majority of the surface strata in Louisiana persist to the present time. Every several hundred years the lower Mississippi River abandons its course and begins to form a new lobe of deltaic sediment. This happens when the old course has become longer and higher, and has a lower gradient or slope, than an alternative course because of the build-up of sediment deposited by the river and the subsidence of older lobes and adjacent areas.

If left in its natural state, the Mississippi River would have shifted most of its flow to the Atchafalaya course during the 1950s. Since then, however, the U.S. Army Corps of Engineers has held the Mississippi in its present course so that the United States can continue to use the river for navigation and commerce, to avoid the tremendous cost of moving industrial and other operations that depend on its present location, and to prevent flooding. This containment of the river has created the current dilemma of excessive rates of erosion and subsidence, with increased vulnerability to hurricane effects, in the coastal regions of the state. If the river were allowed to shift its course naturally and to flood, its sediment would replenish the wetlands and coastal marshes that are now deteriorating, restore the land as it subsides, and provide nutrients vital to coastal fisheries. As it is, the river is held in an overextended course that has reached the edge of the continental shelf, and most of its sediment now accumulates there and farther out in the Gulf.

Voluminous deltaic and nearshore sedimentation in the Gulf in the past created thick sequences of organic clay, which generated hydrocarbons, interfingered with sand, which contained them. High rates of subsidence, sedimentation, and salt migration produced the faults, folds, and interfingered strata that trapped the hydrocarbons. These aspects of geologic setting made it possible for Louisiana's oil and gas operations to become its largest industrial enterprise. However, production has dropped since the early 1970s, and the state is now a net consumer of hydrocarbons. Much of the present production actually takes place in federally leased waters off Louisiana in the Gulf of Mexico.

Another fuel produced in Louisiana is lignite, a low-grade coal occurring in deltaic sandstone sequences of the Wilcox Group in northwestern Louisiana. The Wilcox lignite seams represent ancient delta-plain peats that became dehydrated and carbonized with burial and increasing age. Lignite is mined in De Soto and Red River parishes. In recent years, coal bed methane (CBM) produced from wells drilled into Wilcox lignite seams has become a promising new source of natural gas.

Nonfuel mineral resources produced annually in Louisiana totaled approximately three hundred million dollars in value in both 2001 and 2002. The most important of these economically is salt mined in south Louisiana at some of the numerous salt domes formed by salt stocks ascending into the shallow subsurface from depth. Until the early 2000s the state's second most important nonfuel mineral commodity after salt was sulfur; it now is no longer mined directly from salt-dome caprock, but is recovered from oil as a byproduct at several localities in south Louisiana. Next in importance are sand and gravel, mined from Pliocene and Pleistocene river and coast-parallel terrace deposits and from Holocene alluvium deposited by the rivers and streams draining them.

Other nonfuel minerals include clay, anhydrite, gypsum, and crushed stone. North Louisiana has extensive exposures of clay in the Claiborne Group, but production also has come from older and younger strata. Bentonite, a special variety of clay formed by alteration of volcanic ash, occurs locally in the Cook Mountain Formation of the Claiborne Group. In south Louisiana clay is mined from Pliocene strata in the Florida parishes, Pleistocene strata in Lafayette Parish, and Holocene deposits in Pointe Coupee Parish. Crushed stone primarily consists of hard sandstone mined from the Catahoula Formation and the Fleming Group in scattered locations in west-central Louisiana. Anhydrite (calcium sulfate) and gypsum (hydrated calcium sulfate) are produced from a single quarry in a salt-dome caprock exposure in Winn Parish in north-central Louisiana (both anhydrite and glauconite, an iron-rich silicate mineral aggregate mined from Claiborne Group strata, are used for surfacing roadbeds in many rural areas). One type of limestone occurs as a mineralized zone in the caprock at this dome. Primary depositional limestone of late Cretaceous age comprises the state's oldest surface strata, restricted to the crests of two salt domes in Bienville Parish. Although not economically important, several diamonds also have been found in deposits associated with a Pleistocene course of the Red River in northwestern Louisiana, less than 100 miles (160 km) south of the diamond-bearing area of southwestern Arkansas.

The groundwater resources of Louisiana are stored in units ranging from the Eocene Carrizo–Wilcox aquifer in northern Louisiana to the Holocene alluvial aquifers found along the Mississippi and Red rivers. Four primary aquifer systems are found in the state: the Southern Hills in the southeast, the Chicot in the southwest, the Sparta in the northwest, and the Mississippi River Alluvial in the northeast. The Chicot and Southern Hills aquifer systems of southern Louisiana contain a majority of the state's potable groundwater. However, the majority of groundwater used in Louisiana is from Pleistocene sands within the Chicot and Mississippi River Alluvial aquifer systems.