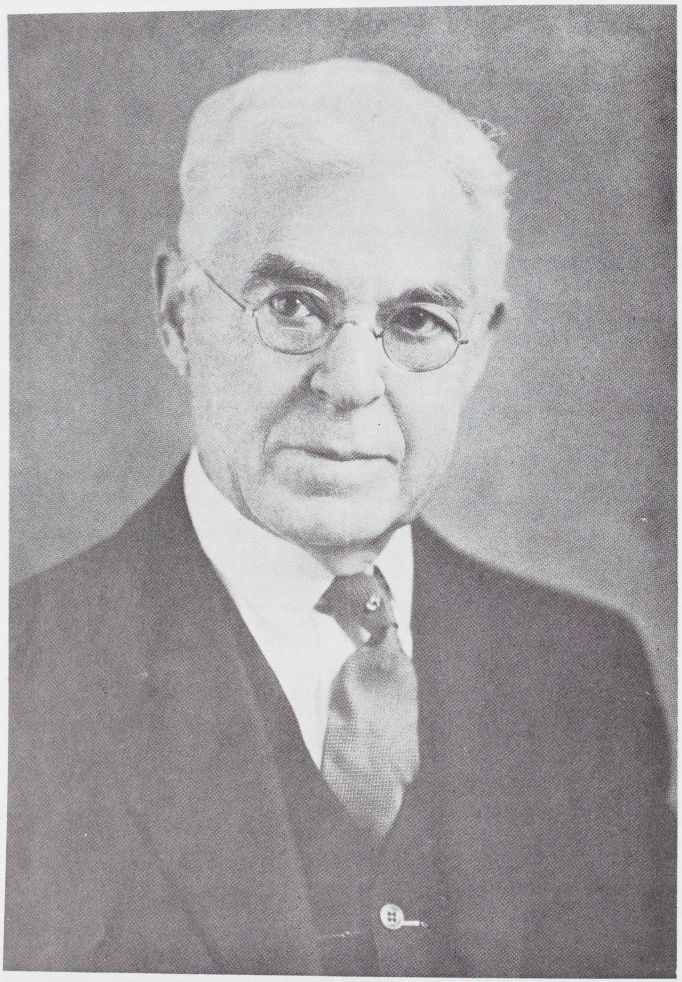

GILBERT DENNISON HARRIS
(1864-1952)

EARLY GEOLOGISTS IN LOUISIANA

HUBERT C. SKINNER

TULANE UNIVERSITY

INTRODUCTION

Louisiana was one of the first areas in America distant from the Atlantic Ocean to attract the attention of travellers and other observers who made geological commentaries on the regions they visited. The great Mississippi River and reports about the potential of the river for trade and access to the immense interior of North America formed the basis for this attraction. Before the year 1900, more than forty individuals did important geological work or made significant observations about the geology of the state of Louisiana. In 1899, Gilbert D Harris and Arthur C. Veatch reviewed the contributions of many of these observers in some detail. Among the early contributors, the work of five men can be considered to be major in its significance to the knowledge of Louisiana geology. These are, in chronological order, John L. Riddell, Sir Charles Lyell, Raymond Thomassy, Eugene W. Hilgard, and Gilbert D. Harris.

EARLY OBSERVERS (1726-1832)

The following list is based largely on the review by Harris and Veatch (1899, pp. 11-44) with additions and emendations from various other secondary sources and primary works. Among the subjects of great interest to travellers were the bluffs at Port Hudson, the Five Islands, the Mud Lumps, fossil bones, marine shells, iron ores, salt springs, and the age and origin of the delta.

1722 — Pierre François Xavier de Charlevoix commented on the recent age of formation of the lower delta region based on "the quantity of shoals and little islands that have been seen to form in the various mouths of the river during the past twenty years".

1726 — Daniel Coxe mentioned "many springs, pitts, and lakes which afford most excellent common salt in great plenty" along the "River *Natchitock*" (some ten or twelve leagues up the Mississippi), which the local Indians used as the source of salt for trade with their neighbors.

1773 — William Bartram, the renowned naturalist, entered and crossed Lake Pontchartrain to the river, which he ascended for some distance above the site of Baton Rouge. He described the varicolored strata in the bluffs at Port Hudson and the plains nearby of "whitish clay or chalk, with veins of sea-shells, chiefly of those little clams called les coquelles *[Rangia cuneata]* interspersed with the white earth or clay, so tenaceous and hard as to render it quite sterile." He speculated about the origin of the cypress stump horizon more than one hundred feet below the edge of the bluffs and how it came to be so deeply buried.

1801, 1803 — William Dunbar of Natchez, Mississippi Territory, communicated reports of fossil bones found west of the Mississippi River in 1801, and again, in 1803, of supposed elephant bones from the "country of the Apelousas." He also reported on the occurrence of oyster shells at depths of 22 feet below the present surface.

1812 — Amos Stoddard, in his *Sketches, Historical and Descriptive of Louisiana*, made several important geological observations. On the Mississippi Delta, he wrote "Nothing is more certain than that the delta has gradually risen out of the sea, or rather that it has been formed by alluvion substances, precipitated by the water from the upper regions. It is calculated that from 1720 to 1800, a period of eighty years, the land has advanced fifteen miles into the sea; and there are those who assert, that it has advanced three miles within the memory of middle aged men." On the Five Islands, Major Stoddard stated "There is an island of about three miles in circumference, situated in the gulf a few miles to the westward of the mouth of the Chafalia, elevated more than two hundred feet above the level of the sea and connected with the mainland by a sea marsh. Most of the islands along the shores of the Mexican gulf exhibit this proud pre-eminence, while the country for a great depth is most of the time covered with water. Some of

them are impregnated with sulphur, and one of them has been known to be on fire for at least three months." Stoddard reported the production of rock salt from saline springs near Natchitoches as about "two hundred and forty barrels of salt per month," and on the cause of the rapids at Alexandria as "two ledges of hard indurated clay, or soft rock which extend across the channel at about three-fourths of a mile from each other," and that "Stone or pit-coal is an article of some importance..." near Natchitoches.

1816, 1818 — William Darby was another perceptive traveller who included geological facts and occurrences within the text of his two travel narratives. He described fully the river systems in the Louisiana area and the terraces or "prairies" in the southwestern region. He visited Petite Anse (now Avery Island) and reported on the salt spring from which salt has been recovered. Darby observed rock exposures on the western side of Sicily Island and correlated them (quite correctly) with similar exposures on the Red River at Alexandria. He noted dead cypress trees in Lake Bistineau and ascribed the origin of this and similar isolated lakes to the "choking up" of smaller stream valleys by the sediments of the Red River. Darby found marine shells in the banks of the Red River, probably at the locality now known as Montgomery Landing.

1821 — Thomas Nuttall compared the ferruginous conglomerates extending for "more than a thousand miles above Alexandria" with the New Jersey conglomerate (later erroneously interpreted as Cretaceous in age by Morton).

1824 — George Graham, in his reports from the general land office for 1824, gave the locations of two salt springs to the north of the Red River.

1829 — Richard Delafield described the topography and the life history of the Mud Lumps in the Passes of the Mississippi.

DEVELOPMENTAL PERIOD (1832-1867)

1832 — Richard Harlan published the first formal, systematic paper on the geology of Louisiana, *Notice of Fossil Bones found in the Tertiary Formation of the State of Louisiana.* This report described the bones of a "huge lizard-like reptile" for which Harlan proposed the name *Basilosaurus.* The locality, in Ouachita Parish, lies about two hundred yards from the Ouachita River and the bones were exposed some forty feet below the present surface "embedded in a bank of sea marl". In addition, the nearby hills were reported as not composed of "rocks", but "a few sandy stones and pebbles, nearly all *siliceous,* are occasionally seen scattered on their summits or in the beds of the numerous creeks fed by springs issuing from them." Further, he observed "Sea shells . . . in several places . . . among others, *pectenites, belemnites,* etc." and that "In these hills very few ores are found except those of iron, which are abundant in two different places; but no measures have been taken to ascertain their value."

1833 — Samuel G. Morton concluded that the "ferruginous sand formation" (reported by Nuttall) and the fossil *Basilosaurus* bones (of Harlan's report) should be assigned to the "Cretaceous Group of the United States."

1834 — Timothy A. Conrad studied the shells found in association with the *Basilosaurus* and referred them to the "Eocene series" and stated that the "commonest fossil is *Corbula oniscus,* a common Claiborne fossil." He suggested that the fossil bones were from a nearby "Cretaceous stratum, not from the Eocene". Later, in 1841, Conrad described additional species of Eocene mollusks from the *Basiolsaurus* locality.

1838 — M. Deméril recognized the vertebrae known as *Basilosaurus* to be from a cetacean rather than a reptile.

1838, 1839 — William M. Carpenter communicated to the American Journal of Science discoveries of fossil vertebrate remains at two localities in southern Louisiana. *Equus* teeth and fragments of the jaw of a mastodon were found on Little Bayou Sara in West Feliciana Parish and additional mastodon bones were found near Opelousas. Also, he re-described the Port Hudson section and traced it eastward in the Florida parishes.

1839-1841 — John L. Riddell worked extensively on the geology of Texas and Louisiana, organized the Geological Committee of the State of Louisiana, and forwarded the results of the Louisiana surveys to the State Printer but these became lost before publication and no trace of this work

is known to have survived. (see full account of Riddell's work below)

1839 — Richard Owen [English] examined new and better preserved specimens of *Basilosaurus* vertebrae which had been brought to him in London by Dr. Richard Harlan and pronounced them the remains of "an aquatic mammal of dugong, or whale-like affinities." In 1841, Owen renamed the species *Zeuglodon cetoides*.

1839 — Captain Andrew Talcott (*in* Totten, 1840) made an accurate map of the mouths of the Mississippi River and prepared drawings of two of the Mud Lumps for a War Department publication.

1841 — A. C. Jones, an engineer, published a careful description of the physical nature of and character of the Mud Lumps in the lower passes of the Mississippi River.

1846 — Sir Charles Lyell visited America for the second time, came to the South, reached Mobile and travelled on through the waters of Mississippi Sound to Lake Pontchartrain and the city of New Orleans. As he went downriver to the mouths of the Mississippi and upriver to Port Hudson and beyond, he made numerous cogent observations about the local geology and the hydrodynamics of the river and its depositional activity. (see full account below)

1848 — Montroville W. Dickeson read a joint paper (with Andrew Brown) before the first meeting of the American Association for the Advancement of Science at Philadelphia. In this paper, *The Sediment of the Mississippi River*, Dr. Dickeson stated that the delta of the Mississippi River has been in the process of forming for at least 14,204 years.

1850 — Daniel Drake gave a good description of the Mud Lumps and proposed the gas theory for their origin within the pages of his medical work *A Systematic Treatise, Historical, Etiological, and Practical, on the Principal Diseases of the Interior Valley of North America, as they appear in the Caucasian, African, Indian and Esquimaux varieties of its population.* In this excellent example of how significant geological work can be concealed in unlikely places, Dr. Drake included a geologic section from a well on Lake Pontchartrain and the exposed section from a gas tank excavation at New Orleans. Further, he described the geological formations at Fort Jessup and stated that their age is Tertiary.

1853 — Charles Ellet, another civil engineer, prepared an extensive work containing plans for flood control and improved navigation on the Ohio and Mississippi rivers. An appendix dealt with the bars present in the passes in the lower delta area. Later in the same year, A. C. Jones published a severely critical review of this book.

1860 — Raymond Thomassy's *Géologie Pratique de la Louisiane*, the first comprehensive attempt to describe the geology of Louisiana was issued (by the author) in New Orleans and Paris, in 1860. Thomassy, an hydraulic engineer, was concerned mainly with the rôle of the Mississippi River in the geological formation of the lower delta region. In particular, he emphasized water absorption and "diminution of volume" gulfward and "volcanic forces" in the origin of the Mud Lumps and the Five Islands which he recognied to be salt intrusions. (see full account below)

1861 — Andrew A. Humphreys and Henry L. Abbott completed their study of the hydrography and geology of the entire Mississippi Basin. They considered the river alluviums to be a thin stratum of river deposits underlain by blue clays of Tertiary or Cretaceous age. The older clays were recognized in the bluffs at Vicksburg, in the Yazoo river valley, and at a depth of about forty feet under the city of New Orleans. Their extensive work was revised and reissued in 1876. In the later edition, the "original mouth" of the Mississippi River was stated to be "near the efflux of the Plaquemine, 220 miles from the Gulf." The yearly advance of the passes of the river was computed at 262 feet, with the advance from the Plaquemine efflux estimated to have taken 4400 years.

1864 — An effort toward a general survey of the geology of Louisiana and its mineral resources began early in 1864 with the appointment by Governor Henry W. Allen of a commission headed by John B. Robertson of New Orleans to begin a systematic investigation of the agricultural, geological, and mineral resources of the state. George P. Merrill (1920, p. 124) in his history of American state geological and natural history surveys stated quite erro-

neously that this was "the first step taken by State authority toward a general survey". The Riddell survey of 1839-1841 was actually the first such "step" authorized by the state and paid for by state funds. Judge Robertson was assisted in his studies by Charles Tripp, mineralogist and metallurgist; John H. Jones, skilled ironmaster; and, Captain John Roy, practical machinist and artisan. The report of the Robertson Survey comprising 25 octavo pages was published in the legislative reports for 1867. The surface geology in central and northern Louisiana was described in very general and simple terms, including mention of "vast hills, sometimes over 200 feet in height . . . unheaved by volcanic action . . . and covered with fragments of red sandstone formerly stratified." This last reference evidently is to the characteristic ferruginous sandstones which had been reported by several earlier observers. The Five Islands were described and were stated to be of volcanic origin. The rock salt of Petite Anse (Avery Island) was noted and compared with the "salines of north Louisiana and their deposits of bones." The iron region of northern Louisiana was reported as quite extensive, and was said to be "so abundant as absolutely at some points to obstruct agriculture." Also, "Vast crops of rich ores may be seen piled up in the fields." Various other mineral deposits were mentioned including lead, copper, limestones, clays, ochres, gypsum and soda springs, lignite, peat, and petroleum.

1865 — Richard Owen [American], then colonel of an Indiana regiment stationed at New Iberia, briefly examined the geological nature of Petite Anse and the deposits of rock salt which had been mined since the early days of the war. Prof. Owen concluded that these islands were not of volcanic origin, but were wind and wave-formed dunes like those along the southern shore of Lake Michigan. The salt beds he attributed to the result of the evaporation of sea water in lagoons behind the protecting ridges or dunes, which were filled and refilled during periods of exceptionally high tides.

RECONNAISSANCE PERIOD (1867-1892)

1867 — Eugene W. Hilgard, working for the Smithsonian Institution, came to Louisiana, travelled down the Mississippi, and made an excursion to the intermediate three of the Five Islands, (Petite Anse or Avery Island, Weeks Island, and Côte Blanche Island). In his preliminary report which appeared in 1869 he attributed the rock salt to being formed by evaporation in a series of lagoons, considered it underlain by early Quaternary marine clays, and explained the hills as accidents of differential erosion. In another work published in the same year he reviewed the geology of western, central and northern Louisiana. Hilgard continued to write on the geology of Louisiana for nearly twenty years. (see full account below)

1869 — Frederick V. Hopkins began his work on the Louisiana survey with three geological excursions during 1869 in northern Louisiana and completed his "first annual report" later in the same year. He described the known geological formations from the Cretaceous to the recent or alluvial formations and included a simple cross-section illustrating his views of the stratigraphic position of the strata and the structure of the area. Hopkins commented on the subsurface section in wells connected with various salt-works and gave a section in detail from the sulphur well at Calcasieu (see Harris and Veatch, p. 33). He suggested that "The sulphur was formed by reducing the gypsum with vegetable matter. The carbonic acid, olefiant gas and the marsh gas produced by the process, have each left the proof of its presence, *i. e.*, the limestone stratum No. 5 contains the former, the petroleum is made from the olefiant gas" and the "small low mounds of that and other regions were formed by the escaping of these gases." He described the lithology, paleontology, and distribution of the "Mansfield group," the "Jackson group," the "Vicksburg formation," the "Grand Gulf group," and the "Drift Period." All of these geologic units had been included in Hilgard's geologic sections. The *Second Annual Report of the Geological Survey of Louisiana* was completed in 1870 and published the following year, accompanied by the first geological map of the state; it is colored. He correlated the "Mansfield group" with marine Jackson beds, and included long lists of Jackson and Vicksburg fossils. The second report is merely a corrected and augmented revision of the first report, to which was added the colored geological map. The

third *Annual Report* is devoted principally to the "Drift" and the alluvium which he traces in terms of its depth and character through much of southern Louisiana. He recorded loess 150 feet thick in the Tunica Hills and included a long list of Paleozoic fossils found in the pebbles of the "drift gravels" which he regarded as Quaternary in age and formed by "an arctic current flowing from Hudson bay."

1870 — Arthur M. Edwards in *Results of a Microscopical Examination of Specimens of Sand obtained from an Artesian Well at New Orleans* reported a gas bearing light grayish sand with fine specks of organic material at 32 feet, clear transparent quartz sand with black organic specks and a "few comminuted mollusks" at 49 feet, and fine sea-bottom deposits with many sea-shells at 71 feet. Edwards recorded *Diatomaceae* of the same species now found living off the coasts of Florida and South Carolina.

1874 — S. Dana Hayes made an analysis of lignite taken from a deposit two miles south of Shreveport, reporting that it "has a specific gravity of 1.143, it is nearly black in color, and its lignitic structure is not so distinct as usual; but it dissolves comletely in caustic soda solution."

1875 — Caleb G. Forshey in his *Report of Survey and Borings made at the Proposed Site of the Lake Borgne Outlet* based on 14 "soundings" to depths of 70 to 100 feet noted marine shells belonging to species now living in Florida waters and reported violent eruptions from depths of 60 to 70 feet of shells and mud with hydrogen gas which "burns with a reddish flame." He compared this with phenomena observed at the Mud Lumps.

1875 — William M. Gabb stated that the Gulf of Mexico was more open in Miocene time than it is today based on his study of the marine Miocene deposits in the West Indies and in Costa Rica.

1884, 1889 — Joseph Leidy published a short report in 1884 on fossil bones from Petite Anse, followed by a longer more detailed report in 1889. He listed *Mastodon americanus, Mylodon harlani* (?), and *Equus major* among the species from Petite Anse.

1885, 1886 and *1891* — Lawrence C. Johnson surveyed the iron ores of Louisiana and northeastern Texas for the United States Geological Survey (published 1888). A map was prepared showing the distribution of the ores and he included drawings to illustrate some exposures. Johnson's stratigraphy follows Hilgard's interpretations, but he found several new localities for fossils and his extensive collections were placed in the United States National Museum. Truman H. Aldrich studied the mollusks and was enabled to correct some previous correlations. In 1891, Johnson published a brief report on *The Nita Crevasse* in which he stated that the Pontchartrain clays (which he correlated with the Port Hudson beds) were deposited during a former period when the Mississippi River debouched through Manchac.

1888 — Frank H. Knowlton described two species of fossil palm wood, *Palmoxylon quenstedti* and *Palmoxylon cellulosum*, from Rapides Parish which had been collected by Johnson in 1886. Later, Knowlton described more fossil wood from other Louisiana localities.

LOUISIANA EXPERIMENT STATIONS (1892-1899)

1892, 1893 — Dr. Otto Lerch worked on the geology of Northern Louisiana during the early part of 1892. Later in the year, he published *A Preliminary Report upon the Hills of Louisiana, North of Vicksburg, Shreveport and Pacific Railroad*, a work of 52 pages with text-figures largely concerned with the description of localities along the route of the railroad. He provided an account of Rayburn's Salt Works, including the stratigraphy of the area and was the first observer to report Cretaceous fossils from this locality. Seven analyses of artesian wells and spring-waters, ten soil analyses, tests on three specimens of iron ore and two samples of lignite, and a list of fossils from the Green Sand Marl northeast of Mount Lebanon were included. Lerch continued with field work during the summer months of 1892, and in 1893 his *A Preliminary Report upon the Hills of Louisiana, South of the Vicksburg, Shreveport and Pacific Railroad* appeared, dealing with the topography, drainage and lakes of the area, followed by the various formations exposed in this portion of the state from the known Cretaceous outcrops at Drake's Salt Works and other localities through the overlying Tertiary beds exposed in this region. These include the

"lower Eocene beds" or the "lower lignitic," the "marine Claiborne" or "upper lignitic" beds, the "Arcadia Clays," the "Jackson beds," the "Vicksburg," the "Grand Gulf," the Red Sandy Clays," the "Sands and Gravel of the Drift," and finally, the "Alluvium." Among the economic materials discussed are the Winnfield "Marble," various building stones, gravels, iron, clay, kaolin, salt, and lignite with analyses of 45 soil samples, ten marls, and four lignites. To explain the northwest-southeast trend of the outcrops, Lerch concluded "that at the close of the Mesozoic time enormous plutonic forces convulsed, fractured, faulted and folded the Cretaceous strata, throwing up mountain chains of vast extent and raising them far above the waters of the Gulf."

1894 — Gilbert D. Harris made a brief visit to Bossier and Claiborne parishes during his work on the Tertiary deposits of southern Arkansas to determine what could be gained from the fossiliferous deposits of Louisiana to assist in classifying equivalent strata in Arkansas. His observations and results were published (1894) in the *Arkansas Geological Survey Annual Report for 1892*. This represents the first involvement of Gilbert D. Harris in the geology of Louisiana.

1895 — Edward D. Cope published notes "On Some Pleistocene Mammalia from Petite Anse, La." Therein, he reported two new species of *Mylodon* and one of *Equus*.

1895, 1896 — T. Wayland Vaughan published *The Stratigraphy of Northwestern Louisiana* based on field work between 1889 and late 1894. Vaughan treated the stratigraphy chronologically beginning with the Cretaceous and continuing through the Jackson, Claiborne (to which he referred Lerch's "Arcadia Clays"), Vicksburg, and Grand Gulf beds. New units described include the "Cocksfield Ferry beds" and the "Sparta Sands." Vaughan opposed Lerch's structural disturbance at the "close of the Cretaceous deposition" and proposed in its place a period of erosion between the Cretaceous and the Eocene strata. in 1896, Vaughan published an expanded version of this work with a bibliography and lists and descriptions of fossils as *United States Geological Survey, Bulletin* 142.

1896 — William W. Clendenin continued the work for the Experiment Stations in 1894 and 1895 with investigations in the "Florida Parishes of East Louisiana" and the "Bluff, Prairie and Hill Lands of Southern Louisiana." His reports on the general topographical features of these areas appeared in 1896. He considered the "Five Islands" to have been uplifted subsequent to the deposition of the Lafayette gravels, rather that the product of pre-Tertiary erosion as suggested by Hilgard. He included several well sections from southern Louisiana in his reports and wrote a general account of the life history and development of a river and related this to the Mississippi River and its development.

1899 — Charles W. Johnson published *New and Interesting species in the "Isaac Lea Collection of Eocene Mollusca"* listing and describing species from the Jackson and lower Claiborne beds in Louisiana.

1898, 1899 — Gilbert D. Harris, assisted by Arthur C. Veatch and others began working on the geology of Louisiana. Harris was appointed as Geologist-in-charge to the Geological Survey of Louisiana and continued in this position until 1909. With Gilbert D. Harris, the early formative stages of Louisiana geological work ended and the modern period of study began. (see full account below)

JOHN L. RIDDELL

Though the primary interests of John Leonard Riddell (1807-1865) were directed toward the other sciences, notably chemistry and botany, and to the field of medicine, his geological contributions were considerable. Riddell's importance to the development of geology in the midwest and the south has been overlooked by historians. For the complete historical treatment of Riddell, his life, and his multifaceted accomplishments see John Leonard Riddell by Karlem Riess (1977), which is a principal source for much of the present narrative.

John L. Riddell's early education was in Massachusetts and New York. From 1827 to 1829 he attended Rensselaer School in Troy, New York, where he studied under Amos Eaton, the celebrated first American teacher of geology. Riddell received his Bachelor of Arts degree in 1829, and sev-

eral years later (1832) was awarded the Master of Arts degree (in absentia). Riddell's first scientific lecture, *A New Theory of the Earth*, was delivered at Rensselaer School on August 16, 1829, and dealt with the various geological formations on Earth and the types of fossil remains found with these formations (Riess, 1977, p. 5-6).

Between 1830 and 1832, John L. Riddell travelled extensively in New York, Ontario, Pennsylvania, and Ohio, presenting public lectures on chemistry, physics, and botany, supported by subscription fees. Late in 1832, he was appointed professor of chemistry and botany at the Ohio Reformed Medical College, Worthington, Ohio. During his two years at Worthington, he began studying the geology of the state, and in 1833, *Geology of Ohio*, his first formal paper on geological subjects was published in the *Western Journal of the Medical and Physical Sciences*. In 1834, he moved to Cincinnati where he attended the Medical College of Ohio and was awarded the M. D. degree in 1836. During 1835 and 1836, he completed several other geological articles, including *On the Vegetable Origin of Coal* (1835), *Geological Features of Ohio* (1836), and *Geological Ramble on the Western Reserve* (1837). In 1836, Riddell married for the first time, and worked on a *Survey of the Geology of Ohio* under Dr. Samuel P. Hildreth. Riddell's portion of this report was submitted and published in 1837.

In October 1836, John L. Riddell and his wife moved to New Orleans where Dr. Riddell had been offered the professorship in chemistry at the New Orleans Medical College. He was destined to reside in this city until his death nearly thirty years later. In 1839, Riddell began his attempts to secure authorization by the State Legislature to conduct a geological survey. In mid-April to late May in the same year and again in mid-September to mid-November, he made geological excursions to Texas, in part to search for Spanish gold and silver mines. His Texas surveys were quite extensive, and one complete volume of Riddell's manuscript *Journal* is filled with his observations on Texas formations, flora, Mexican food, bits of history, and living conditions on these excursions (Riess, 1977, p. 31). *Observations on the Geology of Trinity Couty, Texas* was published in the *American Journal of Science and Arts* in 1839 with detailed descriptions of the soil, rocks, springs, and terrain of the region surveyed. He included analyses of waters from the mineral springs and commented on the brown coal or lignite deposits and their commercial possibilities as fuels — long before the time of Robert T. Hill!

Finally, in 1841, the Geological Committee of the State of Louisiana was appointed with Riddell as Chairman. The other committeemen were Dr. W. M. Carpenter, Dr. Thomas Ingalls, Dr. Josiah Hale, Caleb G. Forshey, and P. E. Trastour. The results of their work were turned over to the State Printer but, tragically, were lost before being published and no trace of the manuscript is known to exist today. The specimens collected by the Geological Committee were left with the Medical Department of the University of Louisiana.

In 1844, John L. Riddell was appointed to the State Flood Prevention Committee by the Governor of Louisiana. In 1845, *Deposits of the Mississippi and Changes at its Mouth* was read before the Association of American Geologists and Naturalists and later was published in DeBow's *Commercial Review* as *Sedimentary Deposits of the Mississippi*. Also, a pamphlet *Remarks on the Dynamics of the Mississippi River and other matters pertaining thereto* was printed and distributed in New Orleans. Riddell estimated that 119,250 years were required to create the Mississippi delta (Riess, 1977, p. 38).

In 1851, Riddell conceived of and designed the stereoscopic binocular microscope. He built the instrument and tested it in 1852, and on July 30, 1853, he described his invention before the American Association for the Advancement of Science. This without doubt is the most significant of his scientific or technological achievements. John L. Riddell was one of the founders of the New Orleans Academy of Sciences in 1853, and in 1855, he was elected President of the Academy which honor he retained until his death in 1865. In 1855, the New Orleans Academy of Science revived the Geological Survey project, but as the State Legislature failed to support the project with enthusiasm, the survey was never completed.

SIR CHARLES LYELL

In 1845-1846, Charles Lyell (1797-1875), renowned British geologist, made a sec-

ond visit to the United States of America, a geological excursion during which he came to Louisiana to view and study the Mississippi River and its delta. He reached the city of New Orleans on the 24th of February 1846 by travelling from Mobile through the "inland passage" a natural channel positioned within the offshore bars along the Alabama-Mississippi coast and into Lake Pontchartrain to a landing six miles north of the city. Foremost among the eminent scientists he met with at New Orleans were William Marbery Carpenter and John Leonard Riddell. Dr. Carpenter, first Dean of the Louisiana School of Medicine, had an excellent knowledge of botany and geology and he accompanied Mr. Lyell on an excursion down the Mississippi River to its mouths and on another to Lake Pontchartrain. In 1838, Dr. Carpenter had published an article on Bartram's "fossil forest" at Port Hudson (above Baton Rouge) and was anxious to have his famous visitor examine this section and to render his geological opinion on the locality. Dr. Riddell, professor of chemistry at what is now Tulane University, had calculated from his experiments the proportion of sediment contained in the waters transported annually by the Mississippi River. Charles Lyell utilized the observations of both Carpenter and Riddell and Riddell's experimentally derived figures on river sediments as a basis for his own estimates of the antiquity of the lower delta of the Mississippi River. He further commented on the nature and origin of the "narrow banks, protruded for so many miles into the Gulf of Mexico" and on the relative stability of these banks as demonstrated by comparison of the observed terrane with older maps of the lower delta region. Lyell calculated that the 13,600 square miles of delta must have taken about 67,000 years to form, an observation that is most impressive at this early date.

On March 10, 1846, Charles Lyell left New Orleans and began to ascend the river. At Port Hudson, he disembarked to view the bluffs containing the "fossil forest" as described to him by Dr. Carpenter. Though his examination of Carpenter's locality was greatly hampered by high water, he was able to find a similar buried forest at a higher level and to estimate that changes in the relative levels of land and sea had taken place with a magnitude of approximately 150 feet. At Natchez and at Vicksburg Lyell was able to inspect the great loess bluffs standing 200 feet above the level of the river at Vicksburg and to recognize beneath these wind-transported deposits "a marine tertiary deposit, of the Eocene period, in which we collected many shells and corals." (1849, p. 208)

The visit of Charles Lyell to Louisiana in 1846 was productive and yielded significant observations about Louisiana geology. Especially noteworthy are his comments on the origin of and age of the lower delta, the nature of and origin of Lake Pontchartrain, his descriptions of the exposed Tertiary strata and the overlying loess deposits in the bluffs near Vicksburg, his views on the "fossil Forest" in the bluffs at Port Hudson, and his discussions of the evidences for subsidence and the probable rates of this subsidence in both the Port Hudson area and in the lower deltaic plain of the Mississippi River. For a more complete account of Lyell's observations see *Charles Lyell in Louisiana* (Skinner, 1976, p. 243-248) and for Lyell's own descriptions of his excursions in Louisiana see *A Second Visit to the United States of North America* (Lyell, 1849, v. II, p. 110 *et seq.*).

RAYMOND THOMASSY

Marie-Joseph Raymond Thomassy (1810-1863), a French hydraulic engineer, came to the United States about 1850 and visited New Orleans where he became fascinated with the dynamic power of the Mississippi River and the physical characteristics and origin of the coastal plain of Louisiana. His intense interest and scientific curiosity resulted in *Géologie Pratique de La Louisiane,* published by the author in New Orleans in 1860.

Thomassy was proud, arrogant, ambitious, and an ardent French nationalist. These characteristics produce an unfortunate bias in his work, which must be reconciled before his ideas can be reviewed and evaluated. On one occasion, his arrogance in comparing the Mississippi River unfavorably with rivers in France led to a challenge from a Creole gentleman to a duel over the honor (and power) of the Mississippi River. Thomassy survived the duel with only a painful and disfiguring

facial injury to remind him of the incident.

In his *Geologie Pratique*, Thomassy suggested that the study of the alluvial lands would provide the key to the great problems of Louisiana geology, and throw light upon "analogous terrains of anterior periods." He discussed mineral springs, artesian wells, mud springs and mud lumps, in addition to hydrothermal and volcanic forces and the evidence for subterranean convulsions in forming the Five Islands of southern Louisiana. He stated the need for a map depicting soils and agriculture, and listed native raw materials or "treasures" that should be exploited for the good of the people: plaster, kaolin, plastic clays, limes, and hydraulic mortars.

Thomassy considered the role of water to be the greatest and most active of the geologic "forces" which contributed to the formation of Louisiana, but he considered "volcanic forces" also to be major in importance, especially in the origin of the Five Islands and the mud lumps. He recounted in detail the history of the discovery of the Mississippi River and presented a series of maps depicting the changing nature of the lower delta region.

Thomassy considered the Five Islands, a series of emergent salt domes, to be formed by some sort of volcanic action, concentrated from the saline waters by hydrothermal forces, and elevated by aqueous eruption. He suggested that the salt masses could be exploited as a source of salt. In 1861-1862, the effects of the Civil War resulted in the sinking of pits or shafts at Avery Island (then called Île Petite Anse) to mine salt for local use. Upon receiving word of confirmation of his salt intrusion theory in the origin of these domes, Thomassy returned to Louisiana from France to view the salt pits and to write a supplement to his earlier work (Thomassy, 1863).

Raymond Thomassy described the delta as a mixture of fluvial and marine origins and gauged its advance at 100 meters per year or one mile in sixteen years. He noted a most salient characteristic, the deviation of the lower course of the river from its southward course toward the southeast, and reported on marine shells recovered from sediments beneath New Orleans. Much of the text deals with hydrography, drainage and other engineering problems, subterranean hydrology, submarine hydrology and related topics, most of which is of limited geological interest; however, this is to be expected as he was primarily a hydraulic engineer.

Thomassy's observations are significant and important. He was the first to describe the emergent domes of the Five Islands as salt intrusions and the first to attempt to explain their origin. He figured and described the mud lumps near the mouths of the river and attempted to explain them. He presented a series of maps illustrating changes in the Louisiana coastline between 1684 and 1859, especially in the area of the present Balize delta, and computed the rate of advance of the delta at 100 meters per year. His work was the first comprehensive effort to describe the geology of Louisiana, a monumental project at this early date. For a more complete account of Thomassy and his work see Skinner (1979, in press).

EUGENE W. HILGARD

Eugene Waldemar Hilgard (1833-1916), born and educated in Germany, was State Geologist of Mississippi (1858-1860) and professor of chemistry at the University of Mississippi (1865-1873). In 1867, under the direction of the Smithsonian Institution, Hilgard made a trip down the Mississippi River and to the central three of the Five Islands. The preliminary report on this reconnaissance work appeared in the *American Journal of Science* in 1869. He considered the rock salt to be produced by evaporation from a lagoon or a series of lagoons, overlying early Quaternary marine clays. The Five Islands were interpreted simply as accidents of differential erosion. Later in 1869 *Summary Results of a late Geological Reconnaissance of Louisiana* appeared in the same journal. The geological "terranes" recognized included:

Alluvium	
Port Hudson Group	350 to 600 feet
Orange Sand Group	100 to 175 feet
Grand Gulf Group	sand and claystones
Vicksburg Group	c. 50 feet of marine Tertiary beds
Mansfield Group	lignitiferous beds

Cretaceous Formation	907 feet of limestone sulphur and gypsum beds

To explain the occurrence of the Orange Sand, he suggested that "in late Quaternary times the Gulf coast has suffered a depression to the extent of at least nine hundred feet (perhaps more), and during the Terrace epoch, a contrary motion of about half that amount." He continued with a discussion of *Salines of Northern Louisiana*, including the methods of producing brine from wells from 15 to 1100 feet in depth, and described the artesian wells of Calcasieu at "the head of the bayou Choupique." At the Troy meeting of the American Association (1869), Hilgard read *On the Geology of the Delta and the Mud-lumps of the Passes of the Mississippi*, in which he stated that the delta plain is covered by river deposits only to a "comparatively insignificant depth." The mud-lumps are discussed at length and are attributed to eruption of a mixture of mud, water, and combustible gas.

In 1871 *On the Geological History of the Gulf of Mexico* was read before the American Association, describing a Cretaceous "backbone" passing through the state to the north and northwest with the strata dipping away on either side. In 1872, a Smithsonian memoir *Geology of Lower Louisiana and the Rock Salt of Petite Anse* expanded his views on the origin of the rock salt, and attributed the Five Islands to erosion-formed outlier remnants of a Cretaceous ridge or "backbone" traversing Louisiana, which though once covered by Tertiary deposits had been exhumed. The salt he considered to be of Cretaceous age.

Hilgard's *Supplementary and Final Report of a Geological Reconnoissance of the State of Louisiana*, a 44 page pamphlet published in 1873 under the auspices of the New Orleans Academy of Sciences and of the Louisiana Bureau of Immigration, was termed by Harris and Veatch (1899, p. 29) "the most complete statement of the geology of the State heretofore published." They recommend that "It should be consulted by any and all who care to become familiar with the geology of the State." It certainly is the most complete and definitive work by Hilgard on the geology of Louisiana.

Subsequent work by Hilgard important to Louisiana geology includes *Note on Lignite beds and their Under-clays* (1874), *The Later Tertiary of the Gulf of Mexico* (1881), *Salines of Louisiana* (1883), *Report on Cotton Production in the United States* containing a brief summary of the geological features of Louisiana (1884), *The Classification and Paleontology of the United States Tertiary Deposits* (1885), *The Old Tertiary of the Southwest* (1885), and *The Equivalence in Time of American Marine and Intra-continental Terranes* (1887). For a longer and more complete account of Hilgard's work in Louisiana see Harris and Veatch (1899, p. 23-32).

GILBERT D. HARRIS

Gilbert Dennison Harris (1864-1952) attended Cornell University (1883-1888) and graduated in 1886 in the same class with Robert T. Hill and David White. He pursued graduate study in geology under Henry S. Williams but left Cornell in 1888 to take a position with the Arkansas Geological Survey. The following year, Harris joined the United States Geological Survey where he worked first in the Paleozoic Division and later under William H. Dall in the Cenozoic Division. He continued with his work in Arkansas during 1891-1892 and as a part of this work made his first excursion to Louisiana (see above); the results of his studies of the Tertiary deposits of Arkansas appeared (1894) in volume II of the Arkansas Geological Survey *Annual Report for 1892*.

In 1894, Gilbert D. Harris was appointed to the faculty at Cornell and remained there until his retirement in 1934. For a full treatment of the life and scientific accomplishments of Gilbert D. Haris see Katherine Van Winkle Palmer's *Memorial* (1953), the main source of much of the material in the present narrative.

In 1898, while teaching at Cornell, Harris was appointed Geologist-in-charge to the Geological Survey of Louisiana, and continued in this capacity until 1909. He spent mid-December to late March each year in Louisiana, teaching during the summer and fall at the University and working on reports of the previous field season for the Survey. His capable student, Arthur C. Veatch, became Harris's assistant on the Survey and an instructor at Cornell. Veatch worked in Louisiana for

most of the year 1898 and, in the following year, the first extensive work (354 pp.), *A Preliminary Report on The Geology of Louisiana*, appeared under the joint authorship of Harris and Veatch (1899). This comprehensive report remains even today a standard reference on the geology of Louisiana. After an historical review of previous work on the state, the stratigraphy and economic geology of Louisiana are considered in detail, followed by nine special reports on the geology of specific areas, faunas, floras, surveying, and mapmaking. Among the special reports, *The Five Islands* by Veatch, and *The Cretaceous and Lower Eocene Faunas of Louisiana* by Harris, are of special significance. A *Geological Map of Louisiana* with the outcrops of the strata indicated by colored patterns accompanied the stratigraphic portion of the *Preliminary Report*.

Three years later, *A Report [of 1902] on The Geology of Louisiana*, was published, based on the work of the 1900, 1901, and 1902 field seasons. Jov. A. A. Pacheco, *Assistant Geologist*, joined Harris and Veatch as one of the principal authors for the 1902 report. It consists of eight special reports similar in scope to those in the *Report for 1899;* three are by Gilbert D. Harris, three are by Veatch, one is by Harris and Pacheco, and one is by R. A. Harris of the United States Coast and Geodetic Survey. The first of the reports, *The Tertiary Geology of the Mississippi Embayment* by G. D. Harris, is of special importance in placing Louisiana and its geology into regional perspective and into the general structural framework of the Gulf of Mexico region. A colored map of the Tertiary deposits in the central embayment area, including the state of Mississippi and parts of Arkansas and Tennessee in addition to Louisiana, is a part of this special report. The eighth report, *Oil in Louisiana*, also by G. D. Harris, reviews the beginning of oil exploration activities in Louisiana.

Later in 1902, Veatch left the state survey for the United States Geological Survey to prepare a report on the geology and underground water resources of Louisiana, which ultimately appeared as USGS Professional Paper 46 in 1906. Pacheco remained with Harris and was joined by Leopold Reinecke, Francis L. Whitney, John L. Rich, and several others who served as field assistants for Harris during the next few years.

The *Geological Survey of Louisiana Report of 1905* [published 1907] comprises four papers by various authors based on the 1903, 1904, and 1905 field seasons. These four papers are designated as *Bulletins I, II, III*, and *IV* on the title page of the collected volume, but may be found as separate numbered bulletins of the [first] Louisiana Geological Survey; these are somewhat less common than the collected volume, *Report of 1905*. In similar fashion, the *Report of 1907* contains numbered *Bulletins 5, 6*, and 7 of the Louisiana Geological Survey, each dealing with a discrete subject on some aspect of Louisiana geology or hydrology.

With the establishment of the Geological Survey of Louisiana under the direction of Gilbert D. Harris, the initial or formative period in the comprehension of the geology of Louisiana came to an end. The Harris Survey brought systematic order to the investigation of Louisiana geology and inaugurated the modern period of study.

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REVIEW

PALEOLITHIC SITE OF THE DOUARA CAVE AND PALEOGEOGRAPHY OF PALMYRA BASIN IN SYRIA, Part I: Stratigraphy and Paleogeography in the Late Quaternary, edited by Kazuro Hanihara and Yutaka Sakaguchi. Published by the University of Tokyo Press, 1978, vi + 121 pp., illustrated. Distributed by ISBS, Inc., Forest Grove, Oregon, ...$29.50

The Douara Cave was discovered in 1967 and was found to have been a habitation site for Neanderthal man. This is a report of the 1974 survey of the cave area by the Tokyo University Scientific Expedition to Western Asia.

Douara Cave is about 200 km northeast of Damascus, Syria and only 18 km from Palmyra, the well-known oasis town. The stratigraphy of the deposits and paleoenvironments are discussed in addition to descriptions of the stone implements and other cultural materials. Evidence for the probable remains of a factory site for stone implement manufacture is presented and the site is compared with other similar discoveries in the Palmyra Basin.

Although this work is probably of primary interest only to anthropologists, its significance to the study of fossil man may appeal to a much broader readership among geologists and biologists interested in human paleontology.

—H.C.S.