THE HISTORICAL RECORD OF PALEONTOLOGICAL AND GEOLOGICAL INVESTIGATIONS WITHIN VICKSBURG NATIONAL MILITARY PARK, MISSISSIPPI

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Abstract—Vicksburg National Military Park (VICK), located in west-central Mississippi along the Mississippi River, is best known for its historical significance as the site of a siege that marked a turning point in the U.S. Civil War. Few visitors are aware of the unique geology and important paleontological resources found within the park. In early 2022, an extensive field inventory of these fossil resources was conducted at VICK. In addition to the survey, which documented 72 localities and added more than 200 specimens to the park's collections, a literature review supplemented the field findings to produce a comprehensive report. Through review of past geological research within and around VICK, a historical narrative was revealed. Fittingly, notable historical figures have sought to understand the Pleistocene loess and early Oligocene outcrops that characterize the park, as well as the fossils found within. The 2022 inventory is only the latest chapter in a series of efforts to uncover the geologic history of VICK and will provide a baseline for future research, monitoring, and management of these sensitive, non-renewable resources.

INTRODUCTION

Vicksburg National Military Park (VICK) protects approximately 730 hectares (1800 acres) of land encompassing the historic battlefield site at which Union soldiers besieged the city of Vicksburg during the U.S. Civil War (Fig. 1). While occasional geologic studies have taken place in and around VICK, a park-specific inventory of its paleontological resources had not been conducted until 2022 (Rich et al., 2023). Three new administrative units recognizing sites instrumental to the Vicksburg campaign are now being incorporated into the park's management area nearby at Port Gibson, Raymond, and Champion Hill. These sites were not surveyed as part of the effort to inventory the park's fossils but are expected contain similar resources as those found in the 2022 survey. A summary of VICK's stratigraphy as described in the report is displayed in Table 1.

VICK's most prominent geologic features are the loess bluffs that accumulated along the eastern banks of the Mississippi River during the Pleistocene Epoch. This windblown silt is found throughout the park and is the material through which siege trenches were dug during the Civil War. Within the park's loess are terrestrial and freshwater fossil mollusks and potentially fossil vertebrates, some of which have been documented elsewhere in Vicksburg. In addition, the ancestral Mississippi River has carried and deposited Paleozoic-age gravels in the pre-loess terrace deposits from a wide area, which resulted in various transported or float fossils reworked along VICK's stream gravel bars. These gravels include corals, bryozoans, brachiopods, mollusks, trilobites, and crinoids. VICK also contains outcrops of the upper Oligocene-lower Miocene Catahoula Formation, which is characterized by cross-bedded, chalky sands and interbedded clays as depicted on the Geologic Map of Mississippi (Bicker, 1969). Most notably, within VICK is the entire stratigraphic sequence of the Oligocene-age Vicksburg Group, a marine unit stretching across multiple southern coastal states. The Mint Spring and Byram Formations are particularly fossiliferous, containing fossil corals, bryozoans, mollusks, ostracods, microfossils, shark teeth, and more. The Mint Spring Formation outcrop at VICK is the formation's place of original description (stratotype) and has been investigated by paleontologists for decades.

The 2022 paleontological resource inventory is the first of its kind for VICK, but other historical research tells of a long history of regional geologic interest. Notable scientists have traveled through and worked in the area that is now VICK while traversing the Mississippi River, and their contributions were instrumental in our present understanding of the park's geology. Below we detail the chronology of historic figures who have interacted with and studied the geology or paleontology of Vicksburg, followed by a summary of the inventory's findings.

HISTORICAL PALEONTOLOGY AT VICKSBURG

Pre-Colonial Contact

The oldest known examples of humans interacting with the geology of Vicksburg are from recovered Native American artifacts. The archeological record in this area dates as far back as the end of the last glacial period of the Pleistocene during the Paleoindian cultural period (12,000–10,000 BC). Many artifacts were made using Paleozoic gravels transported down the ancestral Mississippi River. For instance, effigy beads have been found in Mississippi made of jasper, a red or green variety of chert, sourced from transported gravels (Dockery et al., 2008). These beads are estimated to date as far back as the Middle Archaic Period (6000–3000 BC) (Webb, 1971). Other varieties of gravel-transported chert, including flint, have often been knapped and shaped into projectile points. In addition to the Paleozoic gravels, stones from the Oligocene–Miocene Catahoula Formation were also used by Native Americans for a variety of tools (Dockery and Thompson, 2016). The 2022 survey at VICK recovered some of these archeological resources, among the first Native American and pre-Civil War artefacts found within the park (Fig. 2).

There is also evidence that the prominent Oligocene-age rocks exposed at VICK were used for ceremonial purposes during later periods in Native American history. Across many southern states, Mississippian cultural sites (800 to 1600 AD) have yielded large effigy pipes made of Glendon Limestone of the Vicksburg Group (Fig. 3) (Steponaitis and Dockery, 2011). The pipes are of the Bellaire style, which is native to the lower Mississippi River Valley and dates from 1100 to 1500 AD. Fossils characteristic of the Glendon Limestone, such as pectinid bivalves, gastropods, and foraminifera like the dime-

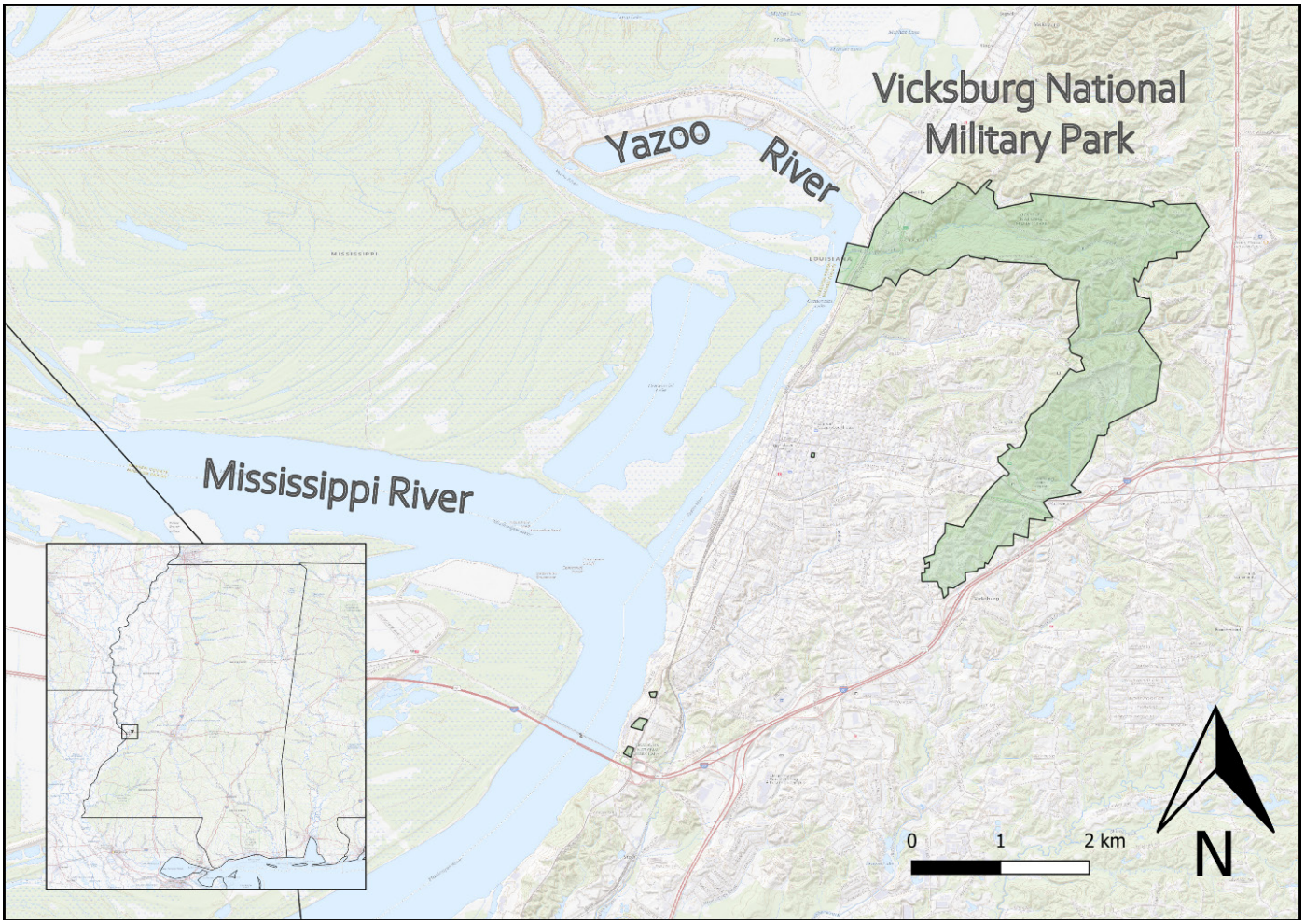


FIGURE 1. Map of Vicksburg National Military Park.

sized, wafer-like species *Lepidocyclina supera*, were identified nondestructively in the stone pipes (Fig. 4). These same fossils were observed in the Glendon Limestone during the 2022 survey. It is highly likely the stone for these effigy pipes was sourced from Vicksburg, and potentially the park itself, due to the proximity of a prominent Glendon Limestone outcrop at VICK located along the Mississippi River and near to historic travel corridors. In addition, there are no Glendon outcrops west of VICK, and outcrops to the east are not as grand in comparison to those found at Vicksburg (D. T. Dockery III, personal commun., 2022).

Pre-Civil War

From pre-colonial times to the early explorations by individuals such as Hernando de Soto, one of the first Europeans to reach the Mississippi River, humans have inhabited and interacted with the lands around Vicksburg. The first trained naturalist to closely observe the geology in the area was the Frenchman Charles Alexandre Lesueur in 1828. While traveling down the Mississippi by flatboat on his way to New Orleans, he came upon beds of fossils at a place called Walnut Hills, which encompasses a portion of the bluffs near the present-day Vicksburg National Cemetery (Fig. 5). According to Hamy (1904), as translated by Haber (1968, p. 56), this trip "would have left a mark on the history of American discoveries through the excavations at Bone Bank and Walnut Hills, had Lesueur hastened a little more to make known the results to the world of science."

From this locality, Lesueur made exceptional collections of fossils from the exposed Byram and Mint Spring Formations, which included foraminifera, corals, bryozoans, bivalves, gastropods, crab claws, echinoids, shark teeth, ray teeth, fish otoliths and vertebrae, and potential manatee ribs (Dockery, 1982b). Lesueur illustrated his findings in a series of twelve plates (Fig. 6), accompanied by a manuscript that is likely the earliest detailed geologic investigation in the state of Mississippi. His collection, sketches, measured section, and notes were divided between the Paris Museum and the Museum of Natural History in Le Havre, his hometown, where his original manuscript is preserved (Gardner, 1938). Photographic prints of the twelve plates were obtained from the Academy of Natural Sciences of Philadelphia and published for the first time in Dockery (1982b, p. 239–250).

Lesueur's investigations were followed by another naturalist, Benjamin L. C. Wailes, who authored "The Agriculture and Geology of Mississippi" in 1854—the first book on Mississippi geology. In this text, Wailes describes the extent of Walnut Hills and defines it as being included within what is now VICK. Before being appointed to conduct a survey of the state for this publication, he had previously collected fossils from the bluffs of Vicksburg. Wailes later showed his collections to the renowned Scottish geologist Charles Lyell during one of his extended stateside visits in 1846 (Lyell, 1849).

Charles Lyell contributed significantly to widely held ideas in the field of geology, such as the uniformitarian principle, which postulates that Earth has been shaped by the same constant, gradual processes happening today. He traveled to the United States twice, touring the country, observing the

TABLE 1. Summary of VICK stratigraphy, fossils, and depositional settings in stratigraphic order from youngest to oldest (Modified from Rich et al., 2023).

Formation	Age	Fossils Within VICK	Depositional Environment
Quaternary sediments	Late Pleistocene loess and Holocene sediments	Pleistocene bivalves and gastropods, possible vertebrate bones	Eolian silt accumulated along eastern banks of Mississippi River
Paleozoic gravel in more recent deposits	Paleozoic origin in Cenozoic deposits	Corals, bryozoans, brachiopods, gastropods, trilobites, crinoids	Glacially deposited sediments from far up the Mississippi River drainage basin, transported downstream
Catahoula Formation	Late Oligocene–Early Miocene	Invertebrate ichnofossils	Sand and clay deposited in coastal and delta environments
Vicksburg Group: Bucatunna Formation	Early Oligocene	Plant material (near park at Keyes Scrap Metal Yard)	Marine regression
Vicksburg Group: Byram Formation	Early Oligocene	Corals, bivalves, gastropods, scaphopods, echinoids, an otolith, foraminifera	Marine regression
Vicksburg Group: Glendon Limestone	Early Oligocene	Shell material, foraminifera, nannoplankton	Marine transgression
Vicksburg Group: Marianna Limestone	Early Oligocene	Shell material, foraminifera, nannoplankton	Marine transgression
Vicksburg Group: Mint Spring Formation	Early Oligocene	Bryozoans, bivalves, gastropods, scaphopods, ostracods, mollusk borings, foraminifera, nannoplankton	Marine transgression, shallow, sand-marl
Vicksburg Group: Forest Hill Formation	Early Oligocene	None to date	Shallow delta, silty sands



FIGURE 2. Projectile point discovered among the Paleozoic stream gravels (Megan Rich/NPS).

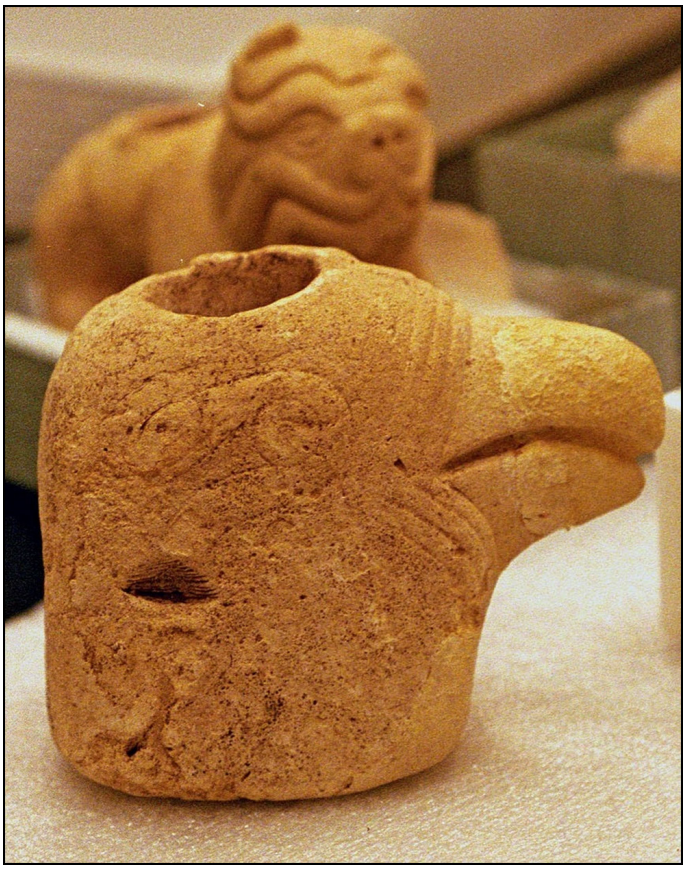


FIGURE 3. Bird-head effigy pipe in the Smithsonian collections collected from the Sycamore Landing site in Morehouse Parish, Louisiana (David Dockery/Mississippi Department of Environmental Quality). The hole in the side is an external mold of the bivalve *Pitar imitabilis*. The pipes in both the foreground and background also contain the common Glendon Limestone foraminifera *Lepidocyclina supera*.

geology, and making fossil collections (Wilson, 1998). In March 1846, Lyell and his wife were traveling up the Mississippi River, leaving from New Orleans before stopping in Natchez then in Vicksburg where he made detailed observations. They approached Vicksburg on March 19, and Lyell described the bluffs of Vicksburg as resembling those seen in Natchez and the Rhine Valley of Europe (Lyell, 1849). On March 20, he collected "many shells and corals" from what is now known as the Oligocene Vicksburg Group and which resembled those from Wailes' collections (Bograd, 1996, p. 53). He recognized the Vicksburg fauna as younger than those of nearby Eocene beds but older than the Miocene Epoch (Lyell, 1849). At the time, Lyell divided the Tertiary Period into three epochs that were, in ascending order, the Eocene, Miocene, and Pliocene. His collections, particularly mollusks from the upper and middle

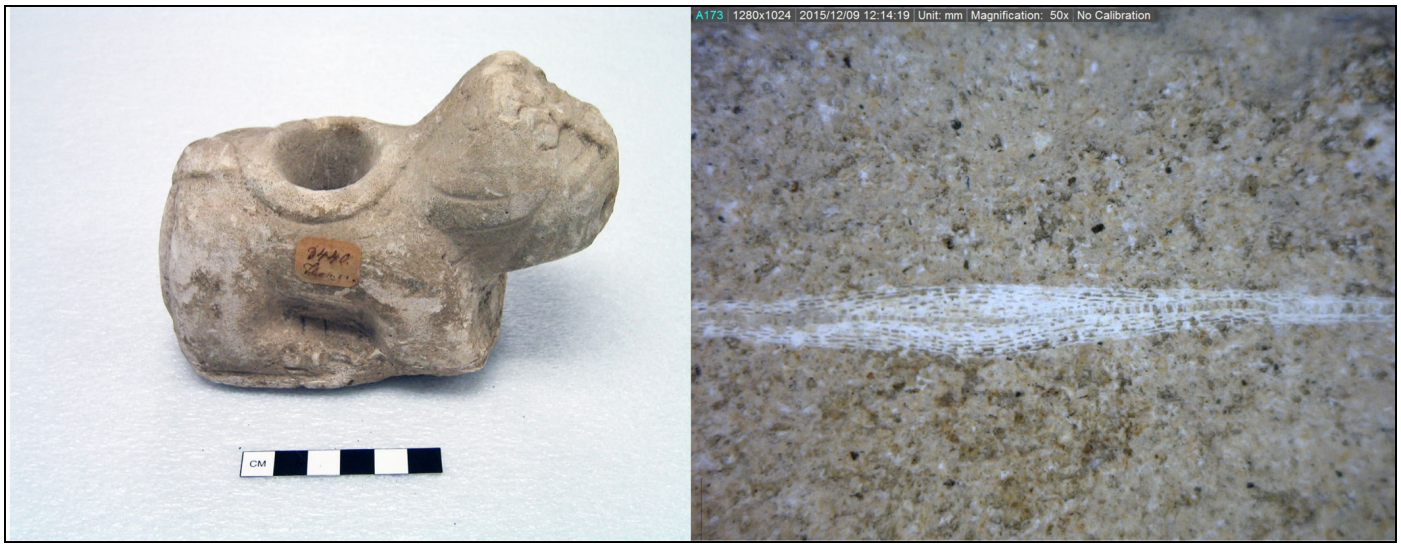


FIGURE 4. Human utilization of fossiliferous stone consistent with a Vicksburg origin (David Dockery/Mississippi Department of Environmental Quality). Left. The Arkansas Hot Springs cat pipe in the National Museum of Natural History. Right. Cross-section of *Lepidocyclina supera* in the Glendon Limestone on the pipe's surface.

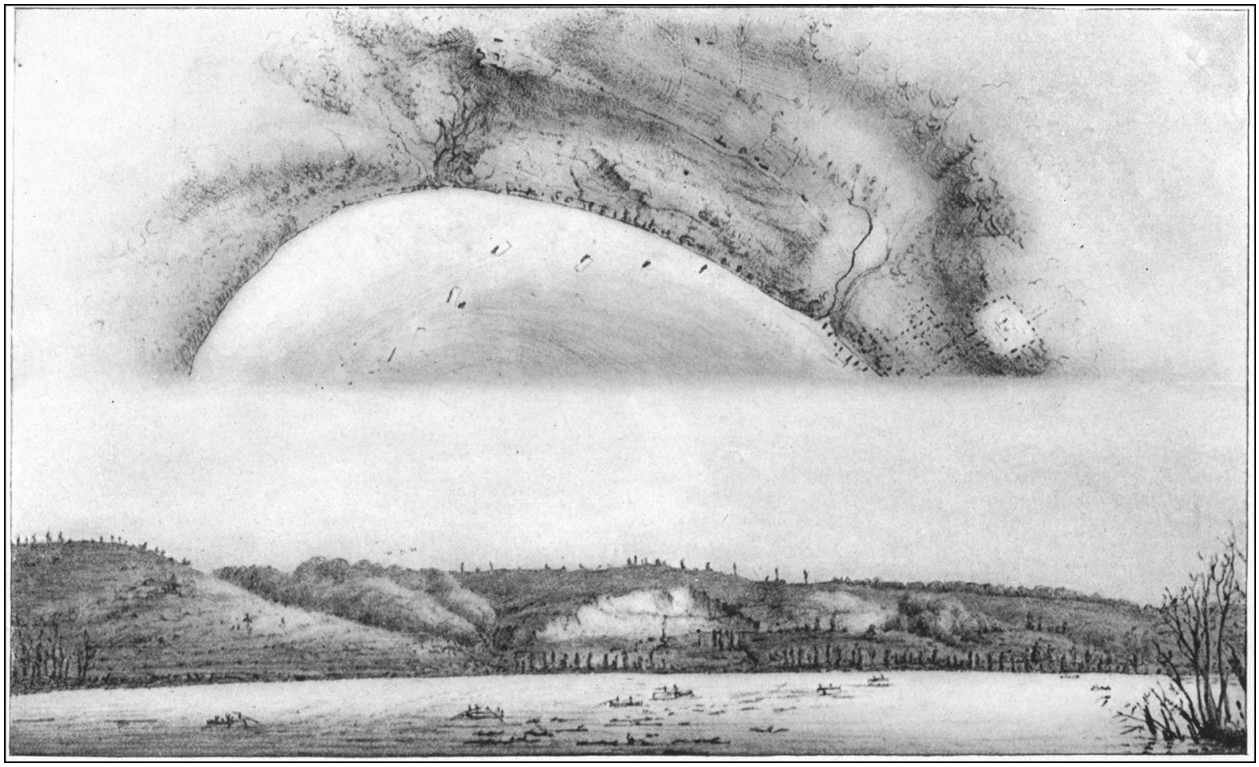


FIGURE 5. Lesueur's sketch of Walnut Hills in 1829 in aerial view (top) and as viewed looking east from a boat (bottom) (Hamy, 1904).

Eocene and lower Oligocene, helped future paleontologists place fossils in the current stratigraphic framework (Hazel et al., 1980).

Timothy Abbott Conrad is another notable figure who spent two weeks in the Vicksburg area to collect Tertiary fossil mollusks in the years immediately preceding Lyell. Conrad had originally held a position as a paleontologist for a survey of New York geology, but he resigned this position to begin studying fossils of the Claiborne Group of Alabama. In the spring of 1844, he shifted focus to the Vicksburg Group and subsequently published his observations, which included descriptions of more than 100 new species (Conrad, 1846a, 1846b, 1848a, 1848b). Conrad's work at Vicksburg and his publication of fossils found were later mentioned by Wailes (1854, p. 237–274). Conrad correlated the section in Mississippi with that of Alabama and his report constitutes the first monograph on the fossils of the Vicksburg Group. After the naming of the Oligocene Epoch by German paleontologist Heinrich Ernst Beyrich in 1854, Conrad published additional articles in which he placed the Vicksburg fossils in the newly labeled Oligocene (Conrad, 1865a, 1865b, 1866). Conrad's plates were reproduced 134 years later in the second monograph on Vicksburg Group fossils in Dockery (1982a).

Civil War

The first known scientists to come upon the Vicksburg area did so as they were traveling along the Mississippi River. This convenient location, often referred to as America's artery, facilitated their visits and later made the city a strategic stronghold during the U.S. Civil War. President Abraham Lincoln famously called Vicksburg the "key," and stated, "the war can never be brought to a close until the key is in our pocket" (Porter, 1885, p. 96). Naturally the contest over this river city brought more people to the area during the war, including the renowned American geologist John Wesley Powell.

Major John Wesley Powell gained prestige serving in the

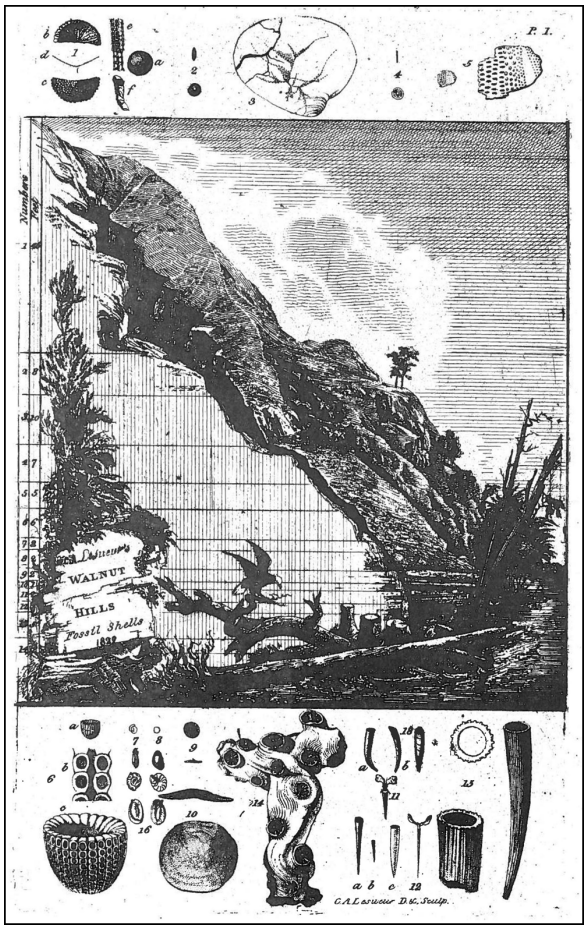


FIGURE 6. Plate 1 of 12 of Lesueur's fossil collections from Walnut Hills (Dockery, 1982a: 239; Mississippi State Geological Bulletin 123).

Union Army under General Ulysses S. Grant as they advanced towards Vicksburg and more so after the war when he became the second director of the U.S. Geological Survey (USGS) and explored the Green and Colorado Rivers. Originally from Illinois, Powell was a teacher and self-taught expert in geology and engineering, partially motivated in these pursuits by the impending Civil War (USGS, 1970). In 1861, he enlisted in the Union Army as a cartographer, topographer, and military engineer. He was present at a number of battles, including the Battle of Shiloh at which he lost his right arm, before participating in Grant's 1863 Vicksburg campaign. His unit, Battery F, later known as Battery Powell, was involved in all five encounters leading up to the siege (Worster, 2001). When the Union army had finally crossed the river to the south, taken the capital of Jackson, and approached Vicksburg, Grant surrounded the Confederate stronghold and laid siege from May 18 to July 4. Grant ordered the construction of 13 zones where men would tunnel through the Pleistocene loess and up to the walls. Battery F took position at Ransom's Approach where Powell quickly took a leading role (Fig. 7). Because of Powell's knowledge of geology and military engineering, Grant made regular visits to the approach and sought Powell's opinions on the terrain (Worster, 2001).

The loess, when cut vertically, remained relatively stable, allowing for trenches to be dug through toward the high bluffs and hills surrounding the city. During the construction of these earthworks, Powell was reported to have made collections of fossils (Stegner, 1954; Worster, 2001), likely Pleistocene gastropods, with the help of his wife Emma (Darrah, 1951). General Grant permitted Emma to join her husband at the front as the siege dragged on and the camp grew. The two carefully wrapped mollusk specimens in scraps of cotton and sent them by post to Wheaton, Illinois before the final assault (Darrah, 1951), though these wartime collections cannot be located today and were potentially destroyed in a fire (Illinois Wesleyan University, personal commun., 2021). Powell was placed on temporary medical leave following the surrender of Vicksburg, after which he was stationed once again in the city. He wintered in Vicksburg, then spent the spring and summer of 1864 instructing a regiment of U.S. Colored Troops on the manning of the city's garrisons (Worster, 2001). In total, Powell was in Vicksburg for roughly one year, and it is believed he may have made additional collections during this time, likely visiting the Mint Spring type locality that is located at VICK (Ross, 2018). Because his collection from this period has not been relocated, Powell's potential interaction with these Oligocene fossils has not been verified. Nevertheless, Powell's participation in the siege at Vicksburg and his notice of the area's fossils constitutes another important chapter in VICK's history.

Another milestone of this period is the Vicksburg Group being codified as a mappable lithologic series of strata for the first time. The state geologist of Mississippi from 1858 to 1866 was a German native named Eugene W. Hilgard. In 1860, he published *Geology and Agriculture of the State of Mississippi*, which included a map that depicted the Vicksburg Group stretching thinly across the state. This, along with the contemporaneous recognition of the Oligocene Epoch in between the Eocene and Miocene (Beyrich, 1954), created a foundation for study of the



FIGURE 7. "Our works before Vicksburg – Battery Powell" sketched by Theodore R. Davis (Harper's Weekly Magazine, July 4, 1863: 420). A man depicted in the image as having only one arm is thought to be John Wesley Powell.

Vicksburg Group as we know it today.

Post-Civil War

Interest in the geology of Vicksburg and its significance increased greatly throughout the next century and beyond. Researchers began coming to the area, especially the Mint Spring waterfall type locality in what is now VICK, for study of particular formations or fossils. While the recent inventory lists these contributions in greater detail (Rich et al., 2023), the following are examples of some of the larger undertakings in and around VICK.

The correlation of the Vicksburg Group has seen numerous variations in the literature. Among the first and most significant papers were those by Charles Wythe Cooke, who focused much of his career on the paleontology and stratigraphy of the Coastal Plain. While working with the USGS, Cooke wrote a series of reports on correlating the units of the Vicksburg Group across Mississippi and Alabama (Cooke, 1918, 1922, 1923, 1935), the first of which named the Mint Spring Formation after the Mint Spring Bayou in VICK (Cooke, 1918). He later published larger studies of mollusks and echinoids, which included specimens observed at Vicksburg localities (Cooke, 1928, 1942, 1959).

One of Cooke's papers was published in tandem with a foraminiferal study from the Vicksburg Group by the famous American micropaleontologist Joseph Cushman. As part of a USGS study, Cushman released a foundational report on the foraminifera of the Mint Spring Formation (Cushman, 1922), followed immediately by the foraminifera of the Vicksburg Group at large (Cushman, 1923). An addendum of more new species of the lower Oligocene of Mississippi was later published (Cushman, 1935). Samples for these surveys came from various localities around Vicksburg, with many collected from within current park boundaries. Cushman's work on the foraminifera of the Vicksburg Group remains one of the most comprehensive studies of lower Oligocene forams to this day.

The correlation of the Vicksburg Group continued to be a topic of study in the years following Cooke's foundational work. F. Stearns MacNeil was another USGS researcher who in 1944 published a paper on Oligocene stratigraphy, which built upon the prior studies and placed the Bucatunna Clay and Glendon Limestone as members of the Byram Formation. This remained the common understanding until these two formations rose in rank after Hazel et al. (1980). MacNeil's work around Vicksburg began with his USGS work in 1937 and carried on through the years, with a final notable publication coming in the form of 411 species, subspecies, and varieties of three mollusk classes of mollusks documented from the Vicksburg Group in MacNeil and Dockery (1984). Like Cushman's foraminiferal study, this publication is an irreplaceable source for information on Vicksburg Group fauna, specifically gastropods, scaphopods, and cephalopods, which are illustrated in detail across 72 plates.

The coauthor on that key publication with MacNeil, David Dockery, is another instrumental figure in developing a wider understanding of the geology and paleontology surrounding VICK. Dockery has made countless contributions to Mississippi geology, including the encyclopedic book *The Geology of Mississippi* (2016), coauthored with David E. Thompson, which was a key resource in preparing VICK's paleontological inventory report. Dockery was named the state geologist in 2017, the year following its publication. Leading up to this, Dockery was the first to publish Lesueur's original plates of Walnut Hills fossils (Dockery, 1982b). Previously the only other published mention of Lesueur's plates in using them for the study of specimens was by Julia Gardner, who was one of the first women to work as a geologist for the USGS and is known for her research on molluscan paleontology of the Gulf Coastal Plain. In 1938, Gardner made note of five unpublished plates with 88 numbered figures and drawings by Lesueur that were held at the U.S.National Museum (Gardner, 1938).

Lesueur's foundation set in motion more comprehensive documentation of Vicksburg's marine fauna, such as Dockery (1982a), a comprehensive report on the bivalves of the lower Oligocene Vicksburg Group in Mississippi. This paper was the first major report on Vicksburg fauna since Conrad's work in 1848 and included 144 species, 45 of which were new, across a series of 62 plates. This was followed by the review of other mollusks in MacNeil and Dockery (1984), as noted earlier, and an examination of the punctuated succession of mollusks through the transgression-regression cycles that characterize the Vicksburg Group's deposition (Dockery, 1986). Dockery's work on Mississippi geology is also relevant to VICK beyond the Oligocene, as his publication on the rocks and fossils found in Mississippi gravels is the best place to turn for understanding VICK's pre-loess terrace deposits (Dockery et al., 2008).

Over the years, successive generations of researchers have investigated the paleontology in and around VICK. Another fundamental study of Vicksburg Group fauna is William Siesser's investigation of calcareous nannoplankton in Paleogene formations of the Gulf Coastal Plain. In Siesser (1983), the author listed taxa recovered from the Mint Spring Formation type locality in VICK and assigned the formation to the calcareous nannoplankton zone (NP) 22. His student, Christopher Hall, revisited the site 20 years later and assigned the Mint Spring Formation to NP 23 (Hall, 2003). Around this same time, the first confirmed vertebrate fossil of the Byram Formation within VICK was recovered by Linda Ivany in the form of a cusk eel otolith belonging to the genus *Ariosoma* (Ivany et al., 2000). Byram Formation otoliths were used in Ivany's isotopic study of climate at the Eocene-Oligocene boundary, which showed seasonal variation in temperatures and cooler winters as a possible explanation for one of the Cenozoic's largest extinctions. Ivany's student, Christy Visaggi, studied the "punctuated succession" of mollusks previously noted in the Vicksburg Group by examining recurring horizons of fossils in the Byram Formation specifically at a locality near to VICK for her Master's thesis (Visaggi, 2004; Visaggi and Ivany, 2010). Neary 20 years later, Visaggi's student, Megan Rich, did her Master's research on Vicksburg fossils for the park leading to this publication and the first comprehensive paleontological resource inventory for VICK (Rich et al., 2023).

In addition to the long history of studying Oligocene fossils at VICK, other efforts have focused on the fossils in the Pleistocene loess. The loess found specifically at Vicksburg was first formally described in a larger report on VICK's geology by William Clifford Morse, another Mississippi State Geologist. Morse (1935) described this loess as originating from glacial action as far north as Canada and then being transported south, later deposited as floodplain material and blown onto the bluffs. The age of the eolian sediments was determined in later studies using fossil gastropod shells collected at various localities, including notable sites near Vicksburg. The first reported absolute age of the loess, in what was at the time the most comprehensive study of the loess in Mississippi (Snowden and Priddy, 1968), was approximately 26,000 to 18,000 yrs. This range was upheld in a more recent publication, which also included Vicksburg samples and correlated the Mississippi loess with loess deposits along the river north to Peoria, Illinois (Pigati et al., 2014).

The loess around VICK has yielded exciting fossil finds over the last century. At least two separate occurrences of mastodon bones have been documented near Vicksburg (Priddy et al., 1966; Kolb et al., 1976). One of these appeared after erosion in the 1950s, and the superintendent of VICK at the time, James R. McConaghie, was consulted. A few decades later, the skeleton was removed in an effort led by Eleanor Daly, the vertebrate paleontologist at the Mississippi Museum of Natural Science (Knox and Pitts, 1984). Daly also later published a list of

occurrences of fossil vertebrates in Mississippi, including loess discoveries, indicating the potential for such vertebrate finds at VICK (Daly, 1992).

The first published research on mollusks from loess in Mississippi was in Shimek (1902, 1930), which recorded snails sampled from Natchez. These early plates include identifications and descriptions that proved useful roughly a century later during the 2022 VICK survey. This early work was built upon in the 1960s by Leslie Hubricht in a report for the Mississippi Geological Survey in which extensive lists of taxa were recorded from numerous western Mississippi counties, including Warren County where Vicksburg is located (Hubricht, 1963). These early papers were referenced frequently in the investigations for the 2022 inventory and were crucial in the identification of taxa recovered.

VICK PALEONTOLOGICAL INVENTORY

Methods

The 2022 VICK paleontological inventory involved a survey which covered nearly two-thirds of the park, excluding physically inaccessible areas and the new administrative units at Port Gibson, Raymond, and Champion Hill (Rich et al., 2023). The survey covered primarily the park's Oligocene Vicksburg Group deposits and the overlying Pleistocene loess. The gravels of the pre-loess terrace deposits which contain Paleozoic fossils and the Oligocene-Miocene Catahoula Formation were also documented. GPS was used to record tracks of the area walked and document the 72 localities at which paleontological resources were discovered. Fossils were documented via field notes, photography, and recording of geospatial locality coordinates digitally and on paper. Fossil specimens were collected periodically with approval from VICK staff for the purposes of establishing a voucher collection and providing specimens for potential future study. VICK previously had no paleontological specimens in the park's museum collections. The survey lasted twelve weeks, and once completed, the results were written in a formal peer-reviewed National Park Service report (Rich et al., 2023). The findings were supplemented using information from existing literature and previous studies which have taken place in and near VICK. Recommendations for preservation of these sensitive sites and resources were also included, as well as other useful management information for park staff.

Results

This park-specific paleontological resource inventory was the first of its kind for VICK, with previous understanding of the park's geology limited to studies performed by individuals not directly affiliated with the park. Through the survey efforts, every formation of the Vicksburg Group was confirmed to crop out within VICK, along with exposures of the Oligocene-Miocene Catahoula Formation. Previously, the only well-known locality of the Vicksburg Group in VICK was the Mint Spring Formation's type locality, which also includes outcrops of the Forest Hill, Marianna Limestone, and Glendon Limestone Formations. Moving upwards stratigraphically, outcrops of the Byram and Bucatunna Formations were also found during the survey.

Fossil collections were made at the Mint Spring locality and several Byram Formation localities and included many species of fossil corals, bryozoans, bivalves, gastropods, and scaphopods. Among these were notable species written, illustrated, and described by the scientists who came before. One example is the large gastropod *Turbinella wilsoni* (Fig. 8) from the Byram Formation, which was first collected by Charles Lesueur at Walnut Hills and later used as the cover of MacNeil and Dockery (1984). While fossils were not collected from the Glendon Limestone in the park due to the indurated substrate, bivalves of the genus *Pitar* and a specimen of the foraminifera

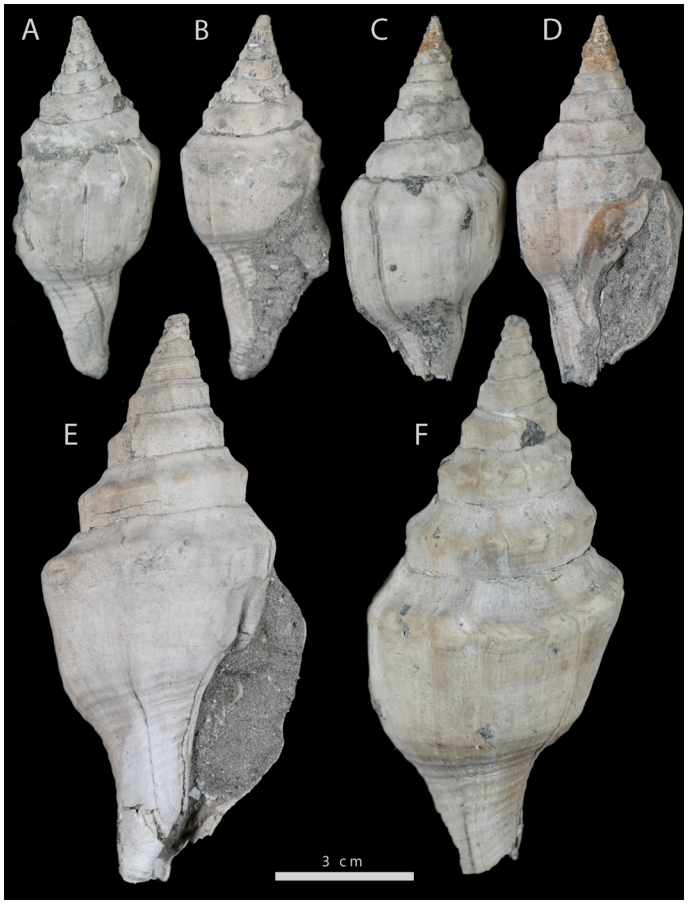


FIGURE 8. Specimens of *Turbinella wilsoni* collected from the Byram Formation in VICK (Charles Beightol/NPS).

Lepidocyclina supera (Fig. 9), guide fossils used to identify the source rock of Native American effigy pipes, were observed embedded in the Glendon Limestone during the survey. In addition to the Oligocene units, collections were also made from the pre-loess terrace gravels and Pleistocene loess. Cobbles in gravel bars were searched for corals, bryozoans, brachiopods, mollusks, trilobites, crinoids, and other fossils. Many were collected, though more dedicated research into these deposits is necessary.

While the pre-loess terrace deposits are less visible and accessible, the loess is a very common sight to both visitors and staff throughout the park. The silt is easily eroded, often causing landslides and subsequently new fossil exposures. This sensitive and ever-changing nature of the landscape makes effective management of the loess terrain a significant concern for VICK. The paleontological resources of the loess consist mostly of terrestrial gastropods, though freshwater bivalves and gastropods as well as fragmentary vertebrate remains were also recovered. Specimens were identified using previous studies of loess fauna sampled in Vicksburg and other Peorian loess sites further up the Mississippi. A preliminary assessment of these specimens revealed a broad diversity of land-based gastropods that included at least 10 different species, with common families including Polygyridae (Fig. 10), Helicinidae, and Discidae. Nearly two hundred fossil specimens were collected from loess localities during the survey, which are expected to be the same kind of shells John Wesley Powell collected from Union trenches. These new collections have yet to be fully identified and offer an opportunity for future research efforts.

Aside from abundant and diverse fossil land snails found at loess localities throughout the park, a handful of sites also

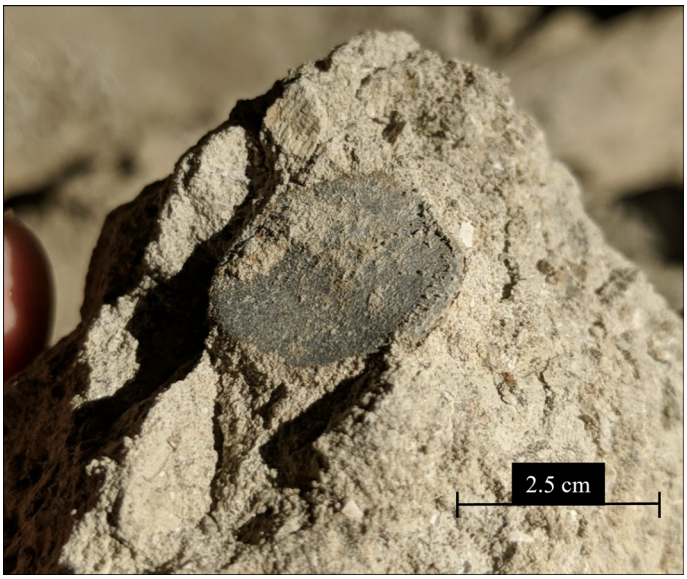


FIGURE 9. A specimen of the foraminifera *Lepidocyclina* embedded in a chunk of Glendon Limestone found at the Mint Spring type locality in VICK (Megan Rich/NPS).

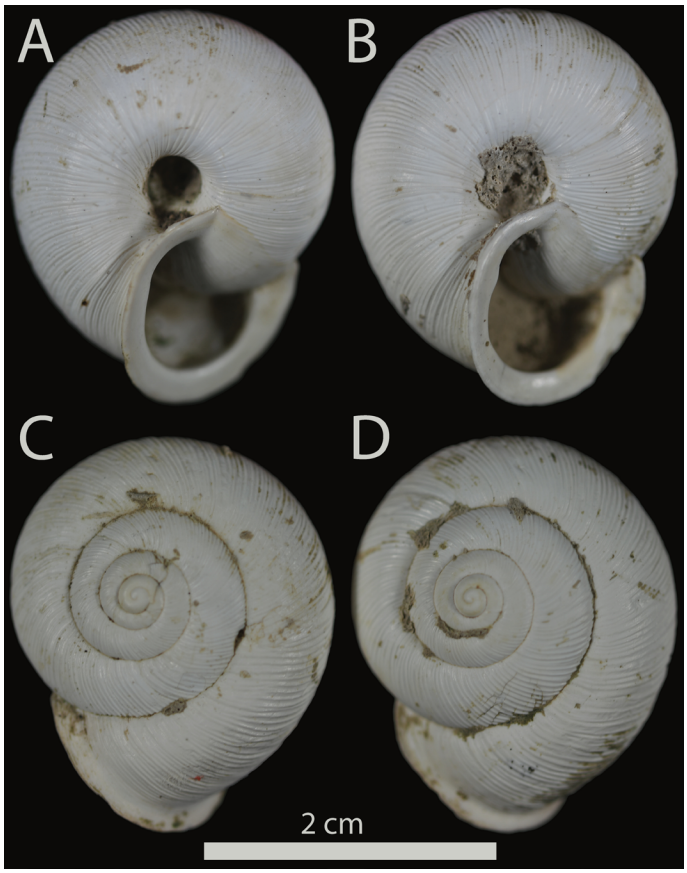


FIGURE 10. "Giant land snails" of the species *Allogona profunda*, which are very common in the loess at VICK (Charles Beightol/NPS).

contained freshwater mollusks. The occurrence of freshwater taxa has been documented in other counties in Mississippi. Pea clams of the genus *Pisidium*, planispiral ramshorn snails of the family Planorbidae, and the amphibious gastropod *Pomatiopsis lapidaria* (Shimek, 1930; Hubricht, 1963) are notable examples. Planorbid snails were especially abundant at a single locality in VICK, but their paleoenvironmental context given preservation in the loess of Mississippi is not well understood in the literature. These freshwater specimens were found near modern streams and could be associated with loess-derived stream alluvium, though future study is necessary to better understand the circumstances of their presence.

CONCLUSION

The study of geology and paleontology that has been undertaken for centuries at Vicksburg has built upon itself over time, much like the layers being studied. The VICK paleontological inventory provides greater context for future scientists to continue the legacy of studying fossils in and around the park. It is necessary, particularly at a park with significant history like VICK, to look back before going forward and recognize the efforts that contributed to our current scientific understanding. It is also helpful for park staff to engage visitors with other exciting historical narratives that intersect with the important natural history of the region. The inventory at VICK provides a baseline for these interpretation goals, as well as paleontological resource monitoring and management recommendations to ensure the preservation of these non-renewable natural resources so that they may be enjoyed and studied by generations to come.

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