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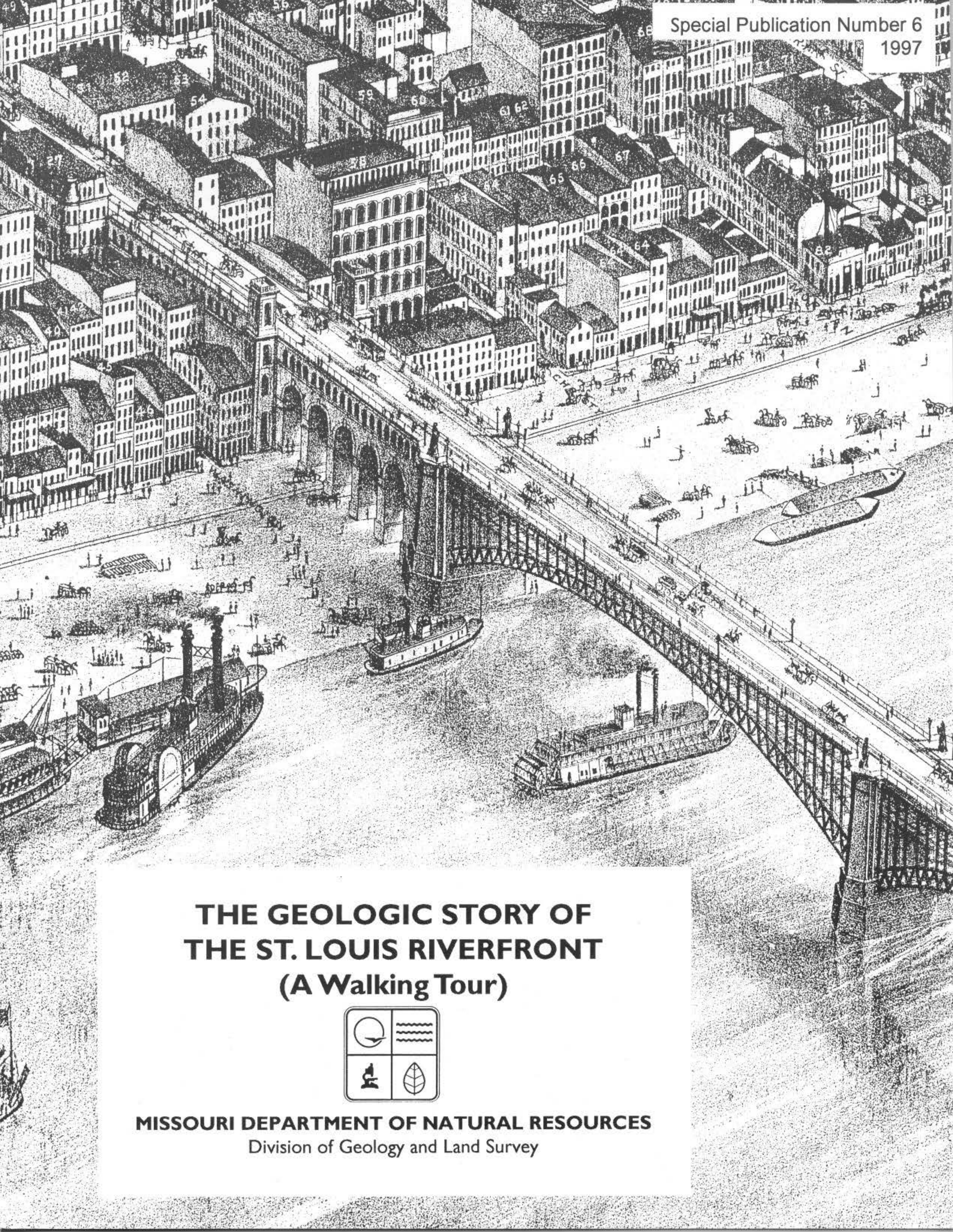

THE GEOLOGIC STORY OF THE ST. LOUIS RIVERFRONT
(A Walking Tour)

MISSOURI DEPARTMENT OF NATURAL RESOURCES
Division of Geology and Land Survey

COVER

West end of Eads Bridge, built 1867-74 by James B. Eads. Five different kinds of stone were used in constructing the piers and approaches. The commercial and industrial district just beyond (north of) the approach is now restored and called the Laclede's Landing historic district. The riverfront buildings on the near (south) side of the bridge were razed in the late 1930's for development of the Jefferson National Expansion Memorial Plaza. From "Pictorial St. Louis," Dry and Compton, 1875.

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THE GEOLOGIC STORY OF THE ST. LOUIS RIVERFRONT (A Walking Tour)

by
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Prepared for
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St. Louis, Missouri

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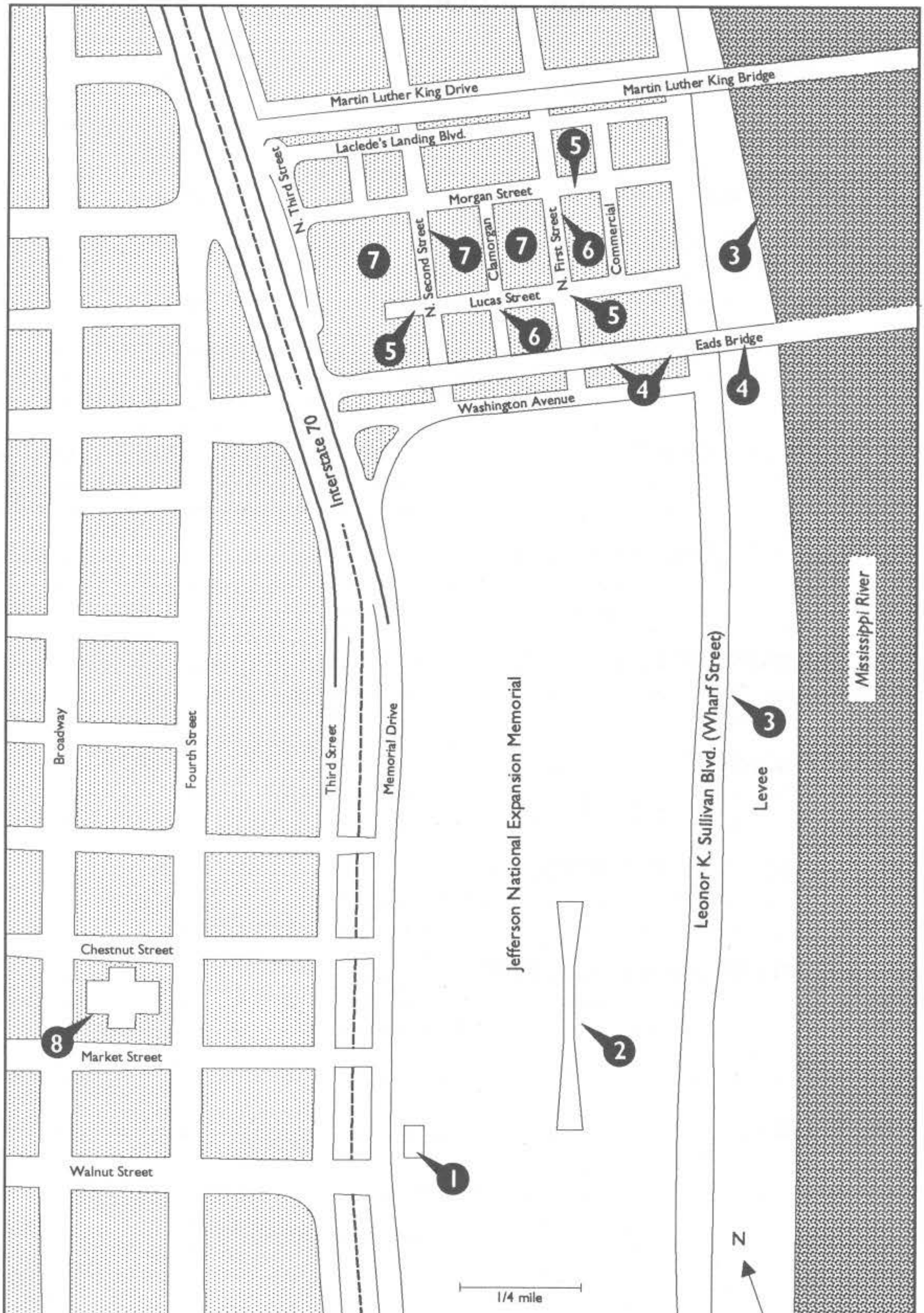


FOREWARD

Each year more than 2 million people visit the St. Louis riverfront. Most come to see and ride to the top of the giant stainless steel Arch. Others stop for a meal at their favorite Laclede's Landing restaurant--on their way to or from the ballpark. Many enjoy the innovative National Park Service exhibits at the Museum of Westward Expansion beneath the Arch, or learn about the early history of the riverfront and St. Louis from displays at the Old Courthouse.

This guidebook was prepared to offer inquisitive riverfront visitors a different perspective--a geological perspective. Geology? But rocks don't even crop out here! The natural rock exposures, including a low limestone bluff which extended along the river, are long gone--most were quarried away and covered over by the mid-1830s. But there are still plenty of rocks to be seen.

For starters, what about the riverfront streets and the levee, paved for a mile with stone blocks? Few visitors forget this pavement--or what they think it did to their car's suspension--but in the glory days of steamboats and dray wagons with iron-rimmed wheels, this was considered one of the finest pavements in America. You will learn from this guidebook that these are not "cobblestones" -- that term refers to naturally rounded beach stones, which were used for pavements at some places on the east coast. These are properly called stone paving blocks. They were shaped by hand, with hammer and chisel, mostly from 1.5-billion-year-old granites and volcanic rocks which outcrop in the St. Francois Mountains of southeast Missouri. If you really want a challenge, you might try your hand at identifying the different rock types, using the chart included in the guidebook.

James B. Eads used five different kinds of stone, each chosen for certain properties to best serve some purpose, when in 1867-74 he built the piers and approaches of his famous bridge (cover illustration). Much of the stone was quarried in Missouri and Illinois, but some was shipped from Maine and Virginia. Six different kinds of construction and decorative stone can be examined in the Old St. Louis Cathedral (built 1831-34), and at least seven different types are seen in the Old Courthouse (built 1839-62). The buildings in the Laclede's Landing area, ranging in age from pre-Civil War to early 1900s, are mostly brick, manufactured from St. Louis clays. The most glamorous buildings in the district are constructed with ornate cast-iron fronts, manufactured by St. Louis foundries, of iron made from Missouri ores. All of these building stones and geologic construction materials are discussed in the guidebook, as well as quarrying, stone dressing, masonry, and construction details.

It would be impossible to tell the geologic story of these St. Louis riverfront landmarks without discussing history. A brief historical perspective is provided for each building, structure, or area discussed.

The Geologic Story of the St. Louis Riverfront was designed as the guidebook for a self-conducted walking tour. The tour consists of eight stops, as indicated on the Route Map (facing page). Total length of the circular route is about 2 miles; the entire tour can be made in as little as two hours, but twice that amount of time is probably more realistic for those who like to go slow and examine more closely.

All of the buildings, structures, and districts described in the guidebook are listed in the National Register of Historic Places. They are all old and historically significant; in some cases they are also fragile. Please treat these historic and geologic treasures with the great care and respect they deserve.

INTRODUCTION

St. Louis, like most of the world's great cities, owes much of her success to geography and natural resources. When Pierre Laclede and Auguste Chouteau founded St. Louis in 1763, their choice of sites was no accident. They had spent several months searching for the perfect situation--a place of permanence on the banks of the Mississippi, as close as practicable to the mouths of the Missouri and Illinois. They knew even then that their little village of St. Louis would someday be a great city.

It didn't take long. Throughout the 19th century, St. Louis' advantageous location guaranteed prominence. In 1805, just a few months after acquisition by the United States, St. Louis became the capital of the vast Louisiana Territory. During the period of westward expansionism, she was successively seat of the Rocky Mountain fur trade, base for early exploring expeditions, a major supplier of goods for the Santa Fe trade, and gateway for miners and settlers immigrating to the far west. During the steamboat era, she was the preeminent transshipping port of the upper riverways. Later she would become an important railroad hub and a manufacturing and mercantile giant.

Mineral resources also contributed to the city's success. St. Louis is located on the fringe of the Southeast Missouri lead district, the greatest lead-mining region the world has ever known. The frontier city's first merchants used Missouri lead in lieu of specie; control of the important commodity placed them in a favorable position to deal for east-coast merchandise. The iron deposits of southeast Missouri were legendary "mountains of nearly pure iron"; until discovery of the Minnesota iron ranges, they were among the most important in the United States. St. Louisans either owned or controlled most of the production, making the city an important early iron founding center. And just across the river was enough good Illinois coal to supply the city's energy needs "forever."

Great cities require endless tons of construction materials to build the urban arenas where they play out their destinies. St. Louis had the resources for that too! Granite, as good for construction as any in the world, was supplied from the St. Francois Mountains, just 80 miles south of the city. The abundance of local limestone varieties provided building stone of all descriptions, as well as crushed stone, lime, and cement. Extensive glass-sand deposits were developed just south and west of the city, and the region's rivers and streams delivered an endless supply of high-quality construction sand and gravel to her doorstep. Large clay deposits of several types allowed the city to become a major manufacturer and exporter of brick and clay products. Just before the turn of the century, St. Louis boasted the largest press brick, fire brick, sewer pipe, and terra cotta factories in the United States.

Most of the important early history of St. Louis was enacted within a relatively small area, near the center of town, and extending just three or four blocks back from the river. The original French village was laid out here, and it was the site of the youthful city's first commercial district. Early St. Louis' most important public buildings and churches were here, and it was, of course, the heart of the city throughout the glorious steamboat era. The great St. Louis Bridge (Eads Bridge), first to span the lower Mississippi River, is located here. In its later years the riverfront area was an important light-manufacturing and warehousing district.

In the late 1930s, 40 blocks of blighted buildings were razed to make way for the Jefferson National Expansion Memorial. The razed area included most--but not all--of the historic St. Louis riverfront district. It is precisely this area, this narrow strip along the river, which is the subject of this guidebook.

Buildings and structures discussed at the eight guidebook stops include the Old St. Louis Courthouse, Old Cathedral (Catholic), stone-paved levee and streets, Eads Bridge, and several old factories in the Laclede's Landing area. Historical background is provided at each, followed by geologic discussion of the stone or industrial mineral products used at that site. In addition to identifying the stratigraphic and geographic source of the stone (where possible), discussions may include mining or milling details, important construction properties or characteristics of the stone, masonry techniques, or evaluation of suitability.

While the field trip area is small, the diversity of geologic materials is great. Twenty different kinds of building, paving, or decorative stone are described, as well as two types of brick, and structural cast iron. Sedimentary and igneous rocks predominate, but a few metamorphic rock types were used. The Precambrian, all Paleozoic periods (except Permian), and the Quaternary are represented. Most of the stone used on the St. Louis riverfront was quarried in Missouri or just across the river in Illinois, but stone from five other states was also used. The stratigraphic and geographic provenances of geologic construction materials used in the St. Louis riverfront district are tabulated in figure 1.

GEOLOGIC TIME: ERAS	GEOLOGIC TIME: PERIODS	CONSTRUCTION MATERIAL	GEOGRAPHIC SOURCE	GUIDEBOOK STOPS
CENOZOIC	QUATERNARY (0)	loess (brick)	St. Louis	2,6
	TERTIARY (2)			
MESOZOIC	CRETACEOUS (66)			
	JURASSIC (160)			
	TRIASSIC (210)			
PALEOZOIC	PERMIAN (245)			
	PENNSYLVANIAN (285)	gray granite/gneiss shale/clay (paying brick) Cheltenham clay	Georgia Western and Central Missouri; Illinois; Indiana St. Louis	3,5 6 2,6
	MISSISSIPPIAN (320)	Aux Vases Sandstone St. Louis Limestone Salem Limestone Warsaw limestone	Ste. Genevieve County, Missouri St. Louis Ste. Genevieve County, Missouri Southern Indiana St. Genevieve County, Missouri (?) Carthage, Missouri	4 1,2,3,5,6,7,8 1 1,6,7,8 1 8
	DEVONIAN (360)	gray granite	Maine; Virginia	4
	SILURIAN (400)	Joliet dolomite	Grafton, Illinois Joliet, Illinois (?)	1,4 1
	ORDOVICIAIN (440)	Kimmswick Limestone Plattin Limestone hematite iron ore	Jefferson County, Missouri Jefferson County, Missouri Phelps County, Missouri	8 8 7
	CAMBRIAN (500)	Bonneterre limestone	Iron, Madison, and Reynolds counties, Missouri	8
PRECAMBRIAN (570) oldest Missouri rocks 1500 - 3800		magnetite/hematite iron ore diabase red\pink granite dellenite rhyolite granite porphyry	St. Francois and Iron counties, Missouri } St. Francois Mountains, Southeast Missouri Minnesota	7 3,5 1,3,4,5 3,5 3,5 8

Note: Numbers at geologic time boundaries indicate millions of years before present.

Figure 1. Stratigraphic and geographic provenance of geologic construction materials used in the St. Louis riverfront district.

1. OLD CATHEDRAL/STONE MASONRY

HISTORY

The Old St. Louis Cathedral (fig 2) is the fourth Catholic church to be located at this site. The first was a small church of log construction built in 1770, just a few years after the founding of St. Louis. It was followed by a second log church in 1776 and a brick cathedral, begun in 1818, but never completed.

Construction of the present church began in 1831. Major contractors included John Whitnell, and Charles Coutts, who supplied all the "cut" stone for $3500, and Hugh O'Neil, Jr., who was paid $6000 to do the stonework, Cost ultimately exceeded $63,000, more that twice the original estimate, Many modifications to the original plans were made during construction, which prompted one observer to describe the result as a Greek Revival church, laid out by American architects, modified by an Italian churchman, and decorated by a French painter. Still, considering the time and place, the accomplishment of its erection was nothing short of heroic.

The Cathedral was dedicated on October 26, 1834. Its beauty was widely praised, and many contemporary authorities considered it the finest

Figure 2. The Old St. Louis Catherdral, from an 1841 lighograph by J.C. Wild. Flanking the Cathedral are an orphanage and the priest's home; both razed about 1850.

religious structure on the American frontier. More importantly, it was the home church of its builder, Bishop Joseph Rosati, and mother church of the St. Louis Diocese, which then extended from the center of Illinois to the Rocky Mountains, and from Mexico and Louisiana to the Canadian border. From his Cathedral, Bishop Rosati sent priests to establish churches in Pine Bluff, Little Rock, Kansas City, and the village that was to become Chicago (150 population in 1833). In 1840, he dispatched the now-famous Father Peter John De Smet as missionary to the Indians of the Pacific Northwest.

Inevitably, the archdiocese and the city outgrew their Cathedral. In the mid-1860s archiepiscopal operations were moved to a larger church, and in 1914 the new St. Louis Cathedral was consecrated. The little church by the river had seemingly outlived its usefulness and eventually fell into disrepair.

In the late-1930s, exciting plans were being made to revitalize the St. Louis riverfront. Ultimately, 40 blocks of blighted buildings were razed to make way for the Jefferson National Expansion Memorial Plaza; the only building spared was the Old St. Louis Cathedral.

In the spirit of the riverfront change, the Cathedral was completely renovated in 1959-61. Citing its historical significance, Pope John XXIII elevated the church to basilican status in January 1961, formally naming it the Basilica of St. Louis the King. Only a few Catholic churches in the world have higher honors.

Today, the Old Cathedral stands virtually alone, next to the expressway that separates modern downtown St. Louis from the Memorial Plaza. But, it maintains a simple grace and dignity, and is still perhaps the most venerable building in St. Louis.

GEOLOGY

The Old Cathedral is constructed almost entirely of stone, and affords an excellent opportunity to observe and discuss two types of masonry, and several kinds of stone.

The church's massive, imposing, porticoed facade is constructed of ashlar masonry (fig. 3). An ashlar is a building stone which has been cut or hewn to an exact size and shape. The other, less-formal walls, are rubble masonry (fig. 4). Rubble blocks are simply blocks of random size and shape, just the way they are broken out at the quarry.

The front wall and columns of the Cathedral are built of massive, very fine-grained, tan-colored dolomite. I have been unable to satisfactorily document the stratigraphic or geographic provenance of this stone. At least two fairly recent authors (not geologists) state that it is Joliet limestone (Silurian), but offer no details or supporting data. While lithologically similar to Joliet dolomite, it is certainly not identical to the Joliet currently quarried at either Joliet or Grafton, Illinois. Commercial production of Joliet, as early as the 1830s, from the type area, is considered highly unlikely.

Early authors wrote that the Cathedral facade was built entirely of "polished" stone. This does not necessarily refer to a "shiny" surface, but indicates that after the blocks were hewn square, using hammers, points, and chisels, the faces were "rubbed" (ground down) with sand until they were absolutely flat. The polished ashlars were laid in courses (horizontal layers), all the blocks in any one course being of equal height. This type of masonry is called coursed ashlar.

The side and rear walls of the Old Cathedral are constructed of St. Louis Limestone (Mississippian). The St. Louis is typically dense to fine grained, sparingly fossiliferous, and rarely contains chert; some beds are dolomitic. It is usually gray when freshly broken, but characteristically weathers to a chalky white color.

Figure 3. Ashlar masonry facade of the Old Cathedral. The dolomite ashlars are about one foot high. This is called coursed ashlar masonry--all blocks in any one course are of equal height. Photo by Art Hebrank.

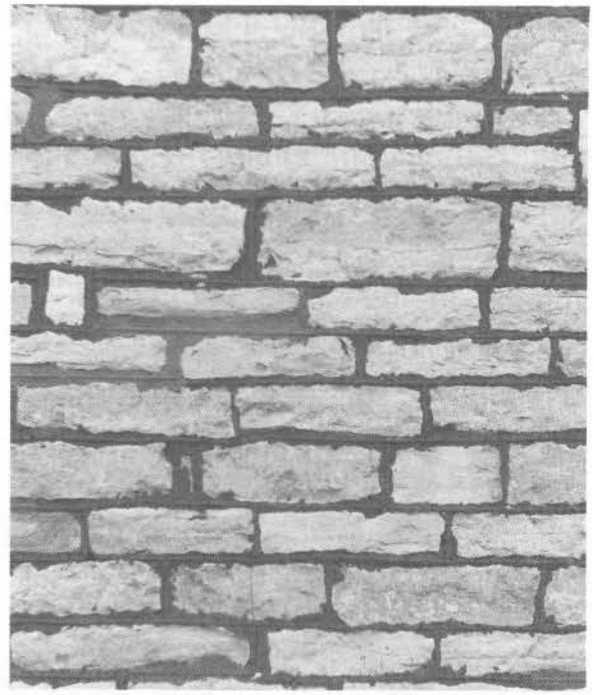


Figure 4. Rlubble masonry west wall of the Old Cathedral. St. Louis Limestone rubble blocks range in height from 3 to 8 inches (same scale as fig. 3). Photo by Art Hebrank.

Several typical St. Louis Limestone lithologies are easily examined in the "exposures" on the Cathedral's west wall. The most recognizable fossil debris consists of echinoderm and bryozoan fragments; several "beds" contain prominent, dark-gray, elongate chert nodules; and the few extensively weathered blocks are dolomitic.

The St. Louis Limestone blocks used to build the Cathedral were probably quarried on the riverfront, no more than a few hundred feet from the site. The mason laid most of this stone essentially the way it was delivered, trimming when necessary to achieve a good fit. Most of the rubble was also scabbled--trimmed with a pick-like tool to a roughly flat face to allow for a good flat wall; prominent pick marks can still be seen on many blocks. The Cathedral's west wall is a fine example of squared rubble masonry--roughly squared stones of various sizes are combined to build up courses as high as the tallest stones.

The rubblework wall is interrupted by a series of especially graceful windows (fig. 5). The high slender openings terminate in Roman arches fashioned of wedge-shaped dolomite blocks. This is the same dolomite used for the church's facade. Window sills are cut blocks of gray, granular Salem Limestone (Mississippian). They are obviously not original elements. Salem Limestone sills, lintels, dimension blocks, and a host of other stock architectural stone products are manufactured in the Bedford, Indiana area and sold throughout the United States under the trade name "Indiana Stone." The Indiana Stone sills were probably installed during the 1959-61 renovation, but may be older.

According to church records, in 1886 the original "hollowed out sandstone" steps at the front of the Cathedral were replaced with qranite. The large blocks of rough-surfaced coarsely crystalline pink granite which now constitute the outer edge of the portico floor were probably laid at the same time. These blocks are pink granite (Precambrian), quarried in the St. Francois Mountains, 80 miles south of St. Louis. The steps on all three sides of the portico are coarsely crystalline dark-red granite which contains a few huge feldspar crystal grains (up to 9 x 5 inches). This is not Missouri granite and I have been unable to document its origin.

The St. Louis Limestone rubble masonry wall which encloses the priest's home and yard (east and north of the Cathedral) was built in 1959-61 to match the old rubblework walls of the church. The stone was quarried in Ste. Genevieve County, Missouri, 60 miles south of the city. The "patch" blocks of gray Salem Limestone that replace dolomite ashlars near the southwest corner of the Cathedral, were probably installed at the same time and also quarried in Ste. Genevieve County.

Not all the stone used in constructing the Old Cathedral was domestic. Installed above the three main entry doors are polished stone slabs with inscriptions in French, Latin, and English. They are imported Italian marble. Similar, but smaller slabs are emplaced on either side of the facade.

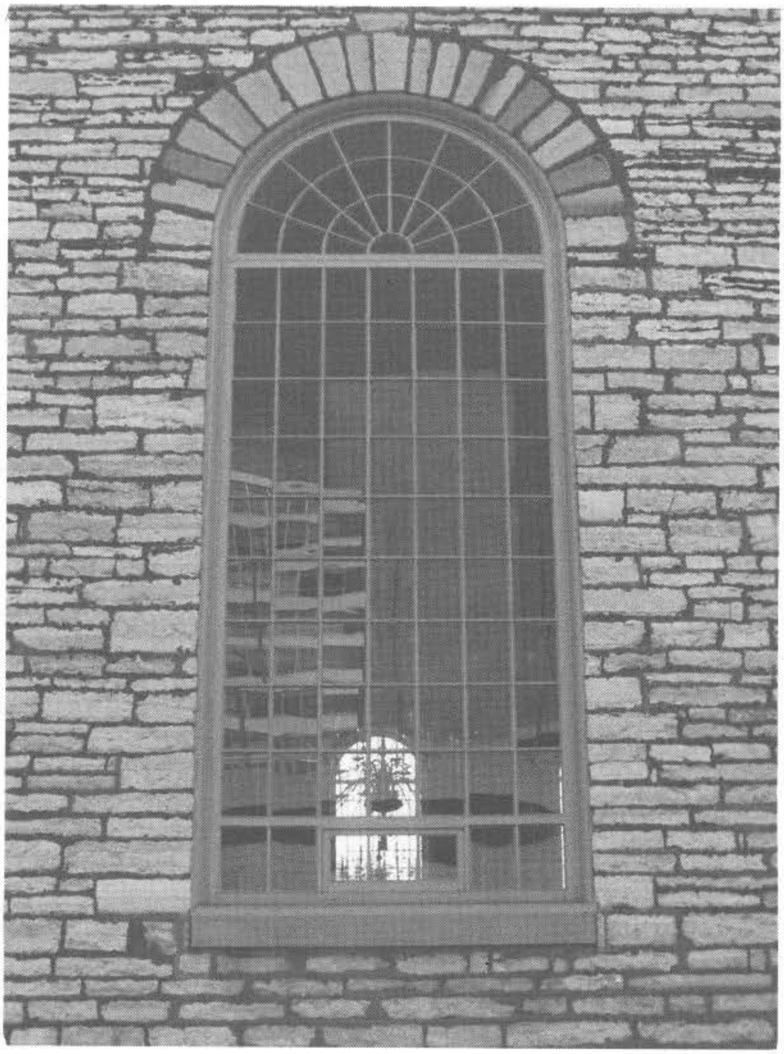


Figure 5. Roman-Arch window in west wall of Old Cathedral. Rubblework wall is St. Louis Limestone; arch is formed of wedge-shaped dolomire blocks, and sill is Salem Limestone ("Indiana Stone"). Photo by Art Hebrank.

2. GATEWAY ARCH/ST. LOUIS GEOLOGY

HISTORY

St. Louis, with an advantageous geographic location and an abundance of important natural resources, early became the commercial center of the Mississippi Valley trade area. During the years of westward expansionism she was successively seat of the Rocky Mountain fur trade, base for early exploring expeditions, a major supplier of goods for the Sante Fe Trail to the southwest, and gateway for miners and settlers immigrating to California, Oregon, and other regions of the far west. As the country prospered and demands for consumer goods increased, the city developed into a major manufacturing center. By 1870, St. Louis had grown to the fourth largest city in America, with a populaion of 310,000.

As the city progressed into the twentieth century, the center of activity gradually shifted away from the river that had first made her great. The business district moved back above Fourth Street, and residential neighborhoods moved even farther west. By the time of the Great Depression, the St. Louis riverfront had become a blighted and seedy area.

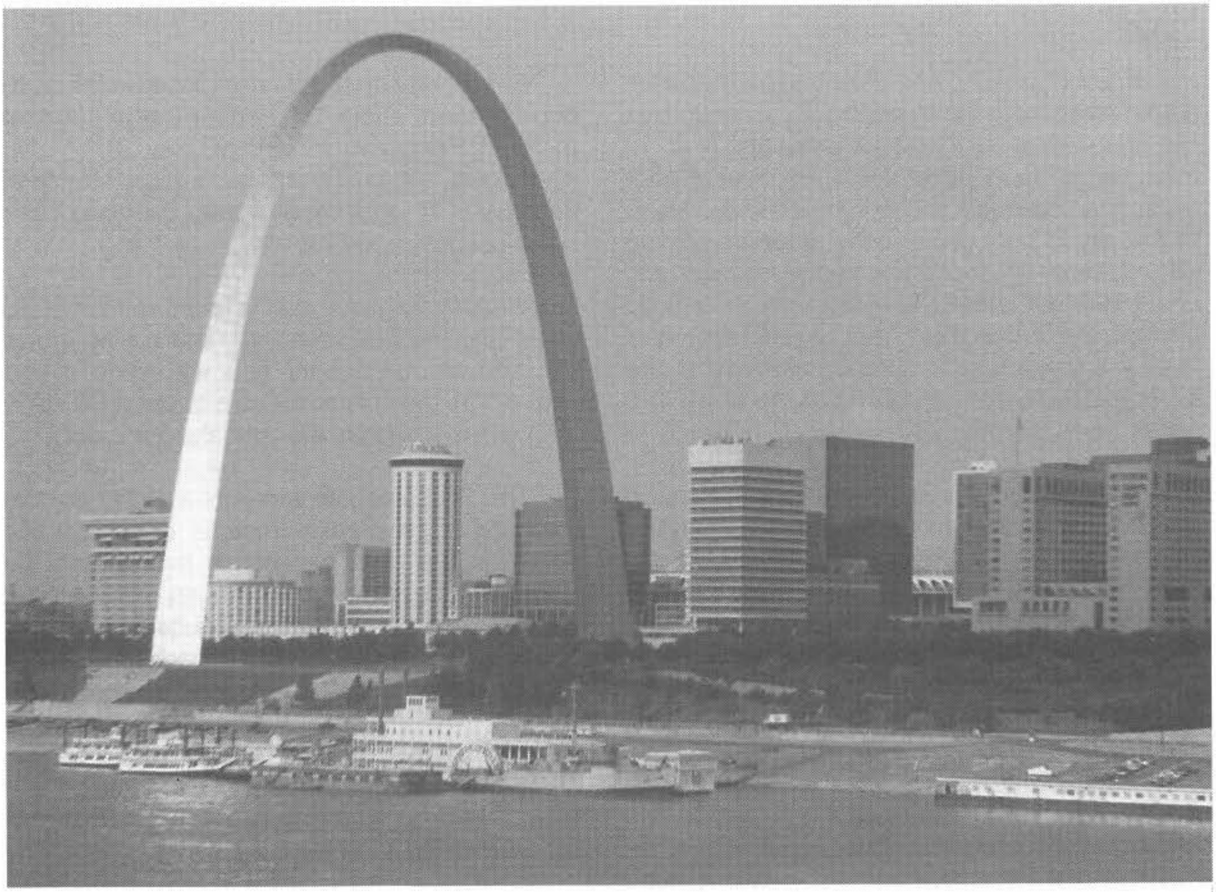


Figure 6. The 630-foot-high Gateway Arch dominates the St. Louis riverfront skyline and is the focal point of the Jefferson National Expansion Memorial Plaza. Photo by Art Hebrank.

Serious discussions were begun in 1933-34 at the city and federal levels to plan a major St. Louis riverfront memorial. St. Louisans approved a bond issue the following year to cover the city's share of the costs. Demolition of a 40-square-block area was completed in 1940, and in 1948 Eero Saarinen's arch design for the memorial was selected in an architectural competition. Federal funds were finally made available and construction began early in the 1960s. The now-famous arch was completed in 1965.

The Gateway Arch dominates the St. Louis riverfront skyline, and is the focal point of the Jefferson National Expansion Memorial Plaza (fig. 6). The graceful stainless steel structure is 630 feet high, with foundations 45 feet deep, footed in St. Louis Limestone. It is the tallest man-made monument in the United States. The monument commemorates Thomas Jefferson and the Louisiana Purchase, all the courageous pioneers who opened the American west to settlement and civilization, and the role St. Louis played in that westward expansion. This colorful episode of American history is illustrated by a number of innovative exhibits in the museum beneath the arch. Since 1967, the memorial has hosted a phenomenal 50 million visitors; 2 1/2 million visited the memorial in 1988.

GEOLOGY

St. Louis is on the northeast flank of the Ozark dome, adjacent to the Illinois basin. It occupies a site on the west bank of the Mississippi River, 12 miles below the mouth of the Missouri, in an area where the flood plain is 6 to 10 miles wide. Much of the city is built on a gently eastward-sloping upland, about 600 to 500 feet above sea level, and about 100 feet above the Mississippi River flood plain. In the downtown area the rise from river to upand is gradual, in a series of steps; bluffs extend directly to the upland at the north and south ends of town.

The geology of the St. Louis area was mapped by 1855 (fig. 7). The entire city is underlain by the St. Louis Limestone (Mississippian), first named in 1847 by George Engelmann. It is as much as 120 feet thick in the type area, and is mostly limestone. Parts of the formation may be dolomitic; some limestone beds contain chert nodules, but they are nowhere abundant. Thickness of individual beds varies from a few inches to several feet. Typically, the St. Louis Limestone is dense or lithographic to fine-grained: some beds are sparingly fossiliferous and solution breccias are locally common, especially near the base of the unit. It is gray to light tan on freshly broken surfaces, but characteristically weathers to a chalky white.

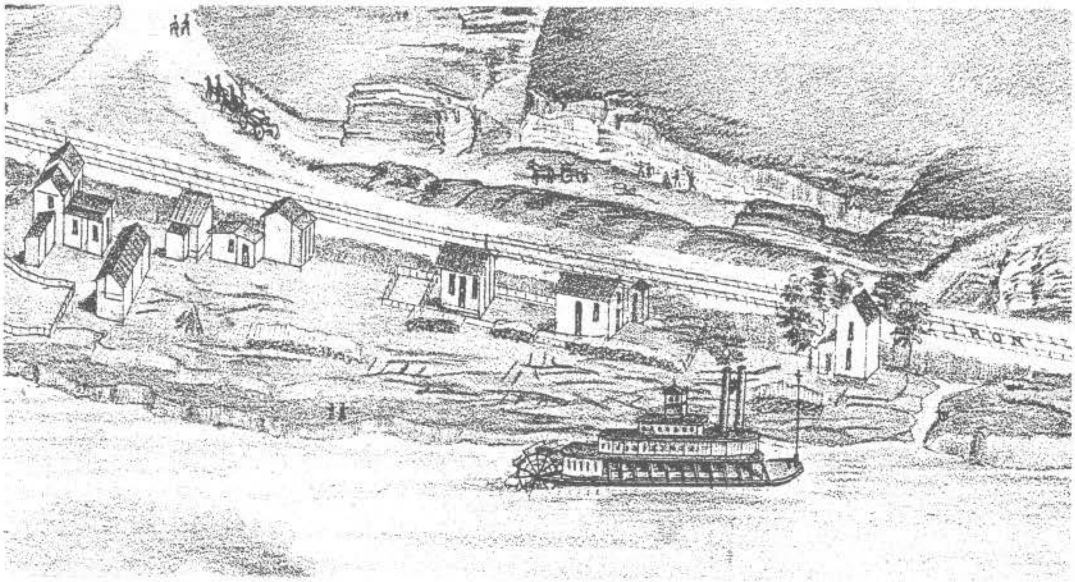
Pennsylvanian strata are exposed at the north edge of town, and a thin veneer (up to 100 feet thick) of Pennsylvanian shale, clay, limestone, sandstone, and coal occupies a slight structural depression on top of the St. Louis Limestone in the south-central part of the city.

Virtually no glacial drift is found within the St. Louis City area, but Pleistocene loess (wind- blown clay and silt) mantles the bedrock almost everywhere. The tan-colored loess is thickest (up to 50 feet) where it caps bluffs right along the river.

The St. Louis Limestone is a highly soluble rock unit. Caves are numerous (about 20 are known in the city), and nearly everywhere the limestone is exposed it exhibits an extraordinary development of sinkholes and subsurface drainage. Many of the sinkholes have been filled to facilitate urban construction. In striking contrast, there are no sinkholes where the limestone is covered by even a few feet of Pennsylvanian shale. A number of St. Louis-area drainage and foundation engineering problems can be attributed to the karst terrane.

The St. Louis Limestone is quarried extensively in the vicinity of St. Louis. In recent years

Figure 7. The Geological Map of St. Louis County, published in 1855 with the First and Second Annual Reports, was one of the first geologic maps made by the Missouri Geological Survey, founded in 1853. The immediate St. Louis City area is underlain by St. Louis Limestone (part of the "Carboniferous Limestone"); in places it is overlain by a thin veneer of Pennsylvanian ("Coal Measures") strata.

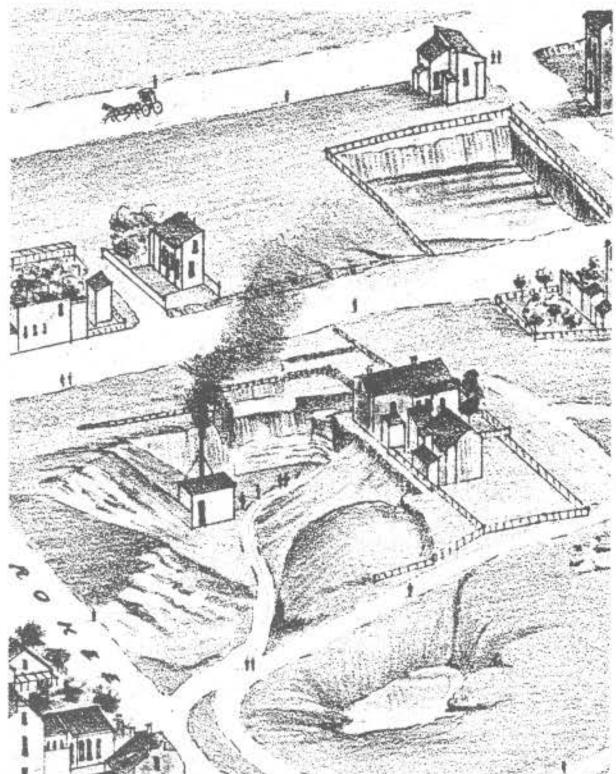


most of the stone has been used as aggregate or in the manufacture of cement. In the past, the same quarries were the source of virtually all the foundation and other common building stone used in the city. The majority was utilized in rubble masonry, and a significant volume was used for paving blocks. Very little St. Louis Limestone was cut or hewn into ashlar building blocks, but some sills and lintels, curbing, and sewer caps were made.

Quarries in the city are of two types, called in the old days (very descriptively) "bluff quarries" and "sunken quarries" (fig. 8). Bluff quarries usually require little machinery other than drills; stone is simply shot down, loaded, and hauled away. Sunken quarries, some up to 125 feet deep, require greater effort. Pumps are used to remove water, and broken rock must be hauled to the surface. In earlier years, steam hoists lifted stone from the pits in detachable wagon boxes.

The Cheltenham clay (Pennsylvanian) of south-central St. Louis at one time supported a major clay-products industry. Manufactured goods included fire brick, ornamental brick, sewer pipe, and terra cotta. Pleistocene loess was utilized for manufacture of common construction brick. Minor amounts of coal, oil, and gas have also been produced in the St. Louis area.

Figure 8. Quarrying the St. Louis Limestone in St. Louis: a "bluff quarry" (above) and a "sunken quarry" (below). From Pictorial St. Louis, Dry and Compton. 1875.



3. LEVEE/STONE PAVING BLOCKS

HISTORY

In the earliest days of St. Louis, a low bluff of St. Louis Limestone extended along the river the entire length of town. Only two east-west streets, modern-day Market and Morgan streets, provided access to the riverfront. They had been quarried down through the rock and were quite steep.

After arrival of the first steamboat in St. Louis, the *General Pike* in 1817, a few far-sighted citizens began to realize the city's potential for river commerce and the need for a levee; however, construction did not begin until about 1835, after the last vestiges of the riverfront bluff had been quarried away. A contemporary writer described the riverfront as a row of fine three-story warehouses along a 10-foot-wide street laid off beside a graduated macadamized (crushed stone) wharf extending to the river's low-water mark.

The port of St. Louis rapidly rose to prominence, primarily because of her geographic and navigational location. The largest riverboats could readily negotiate the lower Mississippi River, but were too large for the much shallower upper Mississippi, Illinois, and Missouri rivers, which required smaller boats. This necessitated unloading and reloading all goods passing the city in either direction, and made St. Louis the great transshipping port of the inland waterways.

If local opinion is to be trusted, the original macadamized levee did not hold up under heavy use; 1840s complainers described its condition as "abominable" and "mostly mud." After extensive improvements in 1845, 1854, and 1857, the city sported riverfront streets and a mile-long levee paved with limestone blocks laid on edge. The blocks were locally quarried St. Louis Limestone.

During its golden age, in the 1850s, the St. Louis riverfront was one of the most famous scenes in America; it was described in glowing terms by many visitors to the city. An average of nine steamboats arrived daily in 1853. It was normal for the mile-long riverfront to be thickly lined with steamers; as many as 170 were counted at one time. The levee was always cluttered with piles of every sort of agricultural and manufactured goods, and was alive with the clatter of barrows, carts, and wagons (fig. 9).

While the Civil War and increasing competition from railroads dramatically reduced river traffic after 1860, the steamboat era was far from dead. In 1880, nearly 2 million tons of freight departed and arrived at St. Louis by riverboat; the wharf remained a vital part of St. Louis commerce. But long years of use had once again rendered the levee pavement inadequate. Iron-shod hoofs and the steel-rimmed wheels of countless heavy freight wagons wore down or broke the limestone blocks and crushed the fragments to powder. Every slight breeze raised clouds of cursed limestone dust.

The first granite paving blocks used in St. Louis were laid about 1877; they were of Graniteville Granite (Precambrian) produced at Phillip Schneider's quarry, 80 miles south of the city. Millions of the hard, wear-resistant paving blocks, or "pavers" as they are called, were subsequently shipped from southeast Missouri producers. There were only 3 miles of granite-block paving in St. Louis in the spring of 1883; by the end of 1885, the city had 22 miles of granite streets. Ten years later it was 48 miles, and by 1900 most of the business district, including the riverfront streets and virtually all of the levee, was paved with granite blocks.

Once the citizenry got used to the loud clatter of steel on granite, they deemed the new paving highly satisfactory. There was no dust or mud, freight costs were less because loads were more easily pulled over the hard uniform surface, and maintenance was minimal.

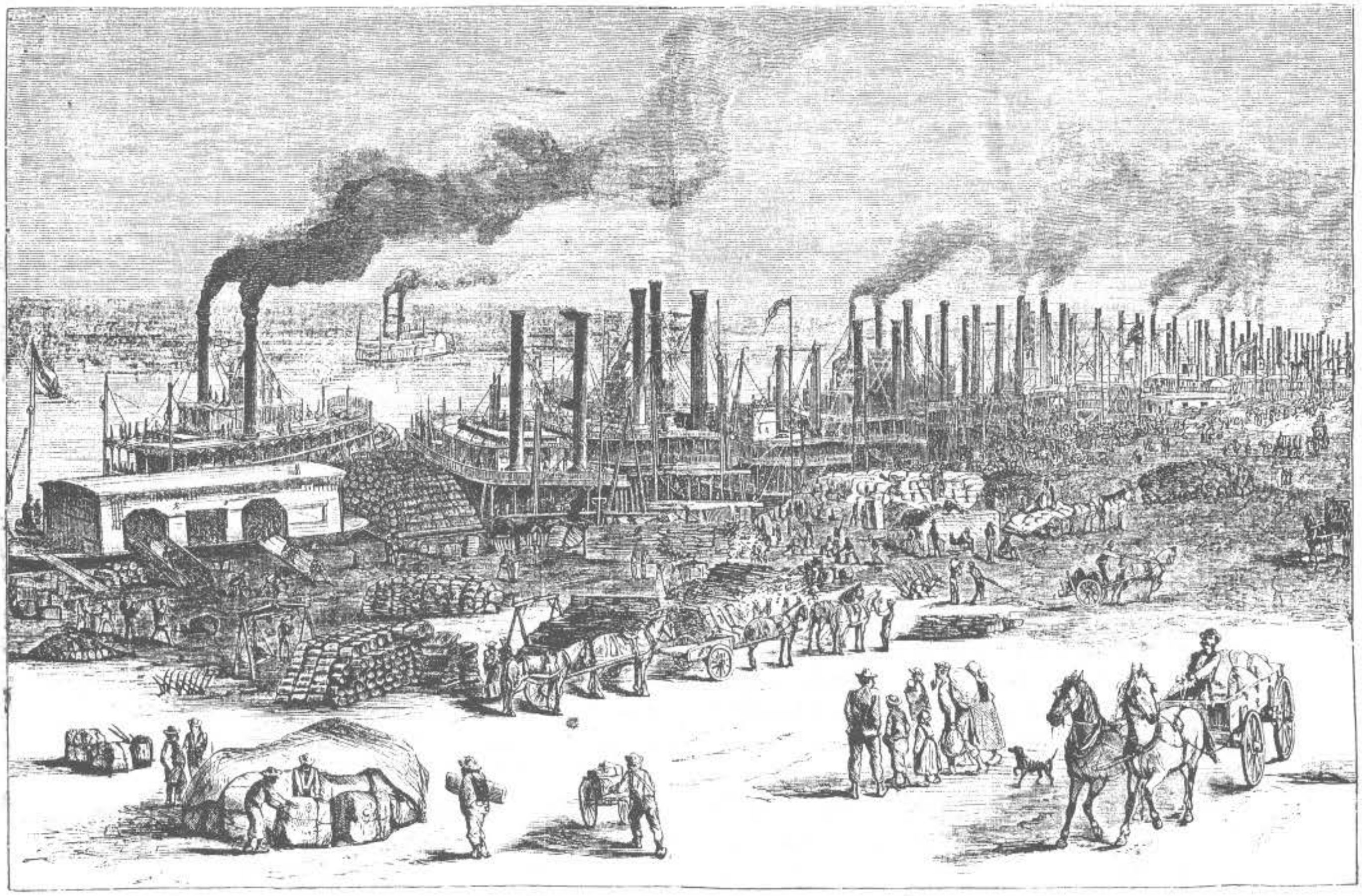


Figure 9. Boats and goods crowd the mile-long St. Louis levee during the golden age of steamboating, probably in the mid to late 1850s. From a woodcut published in Germany in 1872.

The constructional aspects of the levee are but little changed today from what they were at the turn of the century. After a long calm, the riverfront is once again alive with activity. But now it is not the boatman, drayman, or roustabout. Today it is the tourist, come to see and ride to the top of the giant steel arch, or the occasional "weird" student of geology, on hands and knees, examining old paving blocksl

GEOLOGY

Paving blocks were made of stone hard enough to resist the abrasion of steel-wheeled wagon traffic, tough enough to not break under heavy loads, and which would wear evenly and not become smooth (slippery) with age. Granite probably made the best paving blocks. Most of the "pavers" used in St. Louis were Precambrian granite from the St. Francois Mountains of southeast Missouri.

The first extensive granite quarrying operation in Missouri was that of the Schneider Granite Company at Graniteville, Iron County, in 1869. Other important quarries were soon developed near Syenite and Knoblick in St. Francois County. The large quarries mainly produced dimension and monumental stone, but made millions of pavers from the flawed or inferior granite blocks (fig. 10). In the late 1880s, the Schneider Quarry alone shipped 50,000 to 60,000 "pavers" per month.

When the demand for paving blocks was at its peak, many small hillside operations known as "motions" were developed. These were mostly one- or two-man enterprises conducted by individuals who could not assume the expense of opening a quarry. Usually an assistant was hired to drill and split boulders, and the block maker would pay the property owner a royalty of 5 to 10 cents per 100 blocks made. During the last 20 years of the nineteenth century, hundreds of "motions" men were at work in the St. Francois Mountains, and millions of blocks were made.

Paving blocks were made by hand, with stone-dressing hammers and chisels. Granite is relatively easy to work because it usually possesses good rift or cleavage--the property of naturally splitting into blocky masses. This is important because paving blocks should be hewn to as near rectangular as possible, with square edges and corners;

Figure 10. Granite blocks in a quarry near Graniteville, Iron County, Missouri, circa 1890. The inferior or flawed beds were broken down and hewn into "pavers." Missouri Division of Geology and Land Survey archives.

otherwise, the spaces between blocks are too large and the pavement surface is very rough (rougher!). The City of St. Louis adopted a more-or-less standard-size paving block which was 9-12 inches long, 3 1/2-4 1/2 inches wide, and 7 1/2-8 1/2 inches thick. St. Louis "pavers" were slightly thicker than those used in most other large American cities.

In the late 1880s, good granite paving blocks sold for $80 to $90 per thousand (8 or 9 cents each). A good block maker could turn out as many as 70 blocks in a day. This means he completed a block every 7 minutes for 8 hours! But returns were good--an experienced, hard working "motions" man might earn a phenomenal $5 or more per day.

A variety of igneous rock types can be seen in the paving blocks of the mile-long St. Louis levee. Most easily examined are the "clean" blocks (fig. 11) which have been decoratively reset along the levee walkway, just below Leonor K. Sullivan Boulevard (Wharf Street). I was able, during a brief survey, to visually identify at least six different southeast Missouri Precambrian igneous rock varieties (fig. 12). Most St. Louis "pavers" are granite; blocks of Graniteville Granite, Butler Hill Granite, and Knoblick Granite are abundant. Much less common, but certainly not rare, are "pavers" of Skrainka Diabase, Mudlick Dellenite, and several varieties of the volcanic rock rhyolite. Dellenite and rhyolite blocks are inferior; they wear to a smooth, slippery surface because of their very fine grain size.

It is a matter of record that St. Louis also utilized some paving blocks made from Georgia granite/gneiss (Pennsylvanian); they cost a little less than Missouri "pavers." Many of these have a streaked or foliated texture which may weaken them structurally.

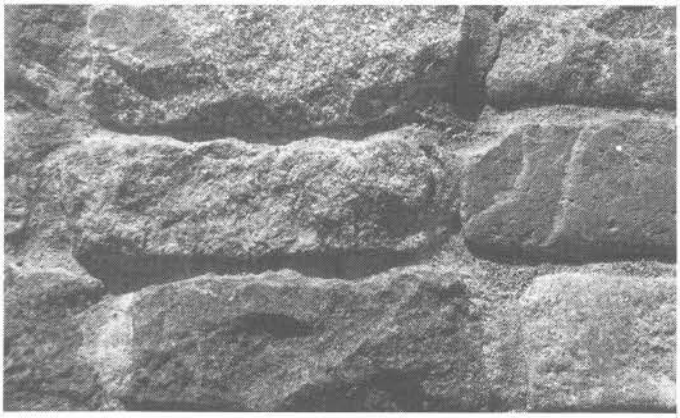


Figure 11. Missouri igneous-rock paving blocks, reset along the levee walkway. Complete blocks are (top to bottom) pink Knoblick Granite, red Graniteville Granite, and black Skrainka Diabase. Photo by Art Hebrank.

Farther north on the levee, a short distance north of Eads Bridge (near the end of the Goldenrod Showboat gangplank), and directly beneath the Martin Luther King Bridge, are several small areas paved with limestone blocks. They are locally quarried St. Louis Limestone (Mississippian). The old limestone blocks, much less uniform in size and shape than typical granite blocks (fig. 13), resulted in a distinctly irregular pavement surface. The rounded tops and broken edges of the limestone "pavers" indicate that this rock is too soft to make a high-quality, heavy-duty, stone-block pavement.

ROCK NAME	COLOR	GRAIN SIZE	DISTINCTIVE CHARACTERIZTICS
Graniteville Granite	deep red	medium-coarse	easily seen glassy quartz grains few dark-colored mineral grains
Butler Hill Granite	pink: light red	medium-coarse	easily seen glassy quartz grains about 5% dark minerals
Knoblick Granite (Adamellite)	mottled, light grayish-pink to bluish-gray	medium-fine	quartz not redadily apparent about 10% dark minerals mafic clots (large dark blotchy areas)
Skrainka Diabase	black; dark greenish-gray	medium-fine	crystal grains elongated (lath-like)
Mudlick Dellenite	dark gray to nearly black	dense (groundmass)	distinct porphyritic texture (light-greenish-gray crystal grains in dense, dark-colored groundmass)
Rhyolite	dark to light red; maroon; brown	dense-very fine	several varieties some have porphyritic texture

Figure 12. Identification chart for Missouri precambrain igneous rocks used for paving blocks on the St. Louis levee and riverfront streets.

Figure 13. Uniform paving blocks of Graniteville Granite (above) and irregular, worn St. Louis Limestone "pavers" (below), on St. Louis levee near Martin Luther King Memorial Bridge. Photo by Art Hebrank.

4. EADS BRIDGE/STONE MASONRY

HISTORY

In the years immediately following the Civil War, the city's business community seriously began to push for construction of a Mississippi River bridge at St. Louis. A bridge was needed to compete with the monopolistic ferry company shuttling railcars across the river, and to guarantee that a sizeable share of transcontinental railroad business would be "funneled" through St. Louis. There were already several bridges across the upper Mississippi, but none where the channel was so wide and deep.

In 1867, James B. Eads (fig. 14), a self-educated engineer and builder, presented to the directors of the Illinois and St. Louis Bridge Company his plans for a triple-span, steel-arch bridge. Details of the proposed structure were published the following year (fig. 15). The design indicated a bridge with three enormous steel arches carrying an upper roadway and lower railroad deck. The center span was to be 515 feet and the side spans just over 500 feet. At the time, it was considered impossible to construct an arch of that length, and few bridge builders anywhere in the country believed Eads' bridge could get beyond the drawing board. But his competitors and detractors failed to reckon with Eads' self confidence and persuasive abilities. His design was selected by the bridge company and he was named chief engineer.

In February 1868 excavation for the west abutment reached bedrock, and it was decided that all four piers would be seated on bedrock. To accomplish this, they had to be lowered through many feet of river bottom sediments. Working in a pressurized caisson, a large crew of laborers, called "submarines," dug sediments from beneath the pier. Successive courses of masonry were added to the top of the pier as it was lowered. This was one of the earliest uses of the pneumatic caisson in the United States and the deepest the caisson had ever gone. When bedrock was reached beneath the east pier, it was 93 1/2 feet below the surface of the river.

Working deep beneath the river was hazardous; the pneumatic caisson was new and the medical profession did not really understand decompression sickness. Working very short shifts seemed to help, but certainly did not eliminate the illness. We know today that after only two hours work in the caisson, almost 100 feet down and under atmospheric pressure nearly three times normal, a "submarine" should have undergone gradual decompression for more than two hours to avoid the "bends." Instead they rarely spent more than 5 minutes in the air lock. The

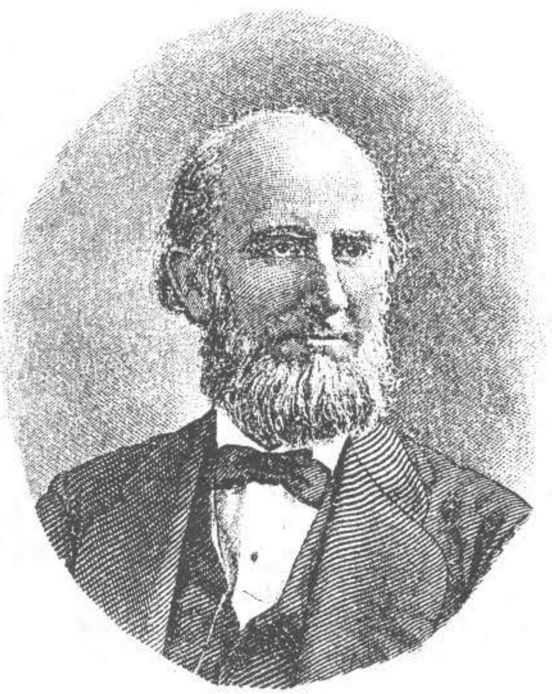


Figure 14. Portrait of James R. Eads, from official invitation to dedication of the Illinois and St. Louis Bridge. July 4, 1874.

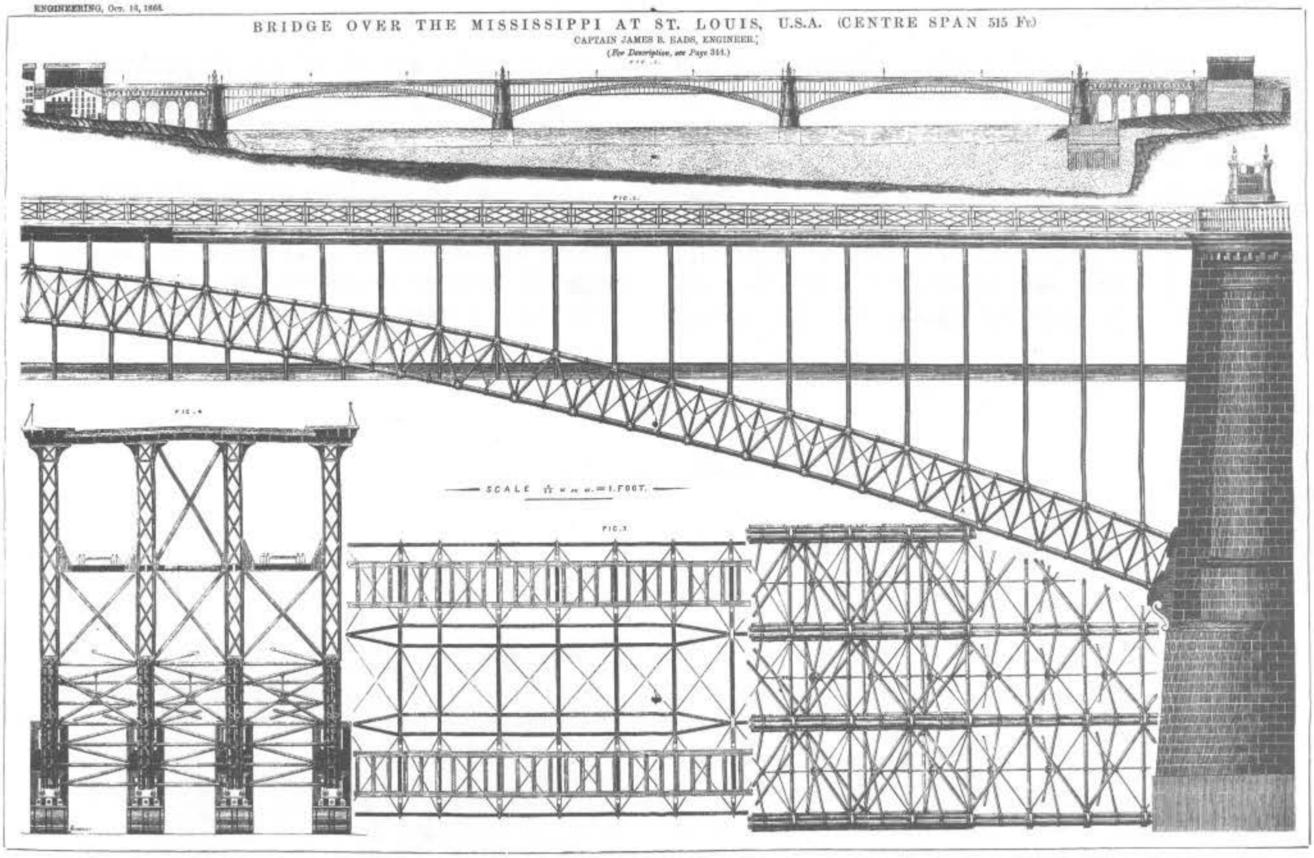


Figure l5. Detailed drawings by Eads for the proposed Illinois and St. Louis bridge published in Engineering, October 16, 1868. Several important changes were made in actual construction, including sinking all piers to bedrock.

concerned "submarines," groping for anything that might offer immunity trom the dreaded sickness, embraced a host of "nearly fool-proof" remedies ranging from special clothes, charms, diets, or tonics, to a complex "electrolytic" scheme involving the application of foil strips to the wrists or under the feet! Of course, nothing worked; of the 600 "submarines" who worked in the caissons, 119 were seriously stricken and 14 died.

Hanging the steel was almost anticlimactic after the difficulties encountered in building the piers. The key structural elements of the metalwork were the carefully designed tubular-steel arches. The St. Louis Bridge was the first major bridge in the world which used steel in the principal members; others had used iron. Eads was very exacting; he and his assistants designed test equipment, checked virtually every element delivered, and sent back anything that did not meet standards. In the end, he was forced to compromise on some of the less important elements, and the bridge contained more wrought iron than he had planned. The steelwork was built outward from each pier, then joined at the centers of the arches. This was the first large bridge erected by the cantilever method, rather than being supported by scaffolding during construction. As completed, the central arch spans 520 feet and each side arch spans 502 feet; all three arches rise 45 feet.

The Illinois and St. Louis Bridge was dedicated on July 4, 1874, before a crowd numbering somewhere between 50,000 and 200,000, depending upon which "historical" account you subscribe to. The lower Mississippi River had at last been spanned, connecting the East with the West across the heartland of America. The Eads Bridge, as it is always called today, was certainly one of the engineering marvels of its day, and its ingenious designer and builder is today still ranked among this country's great engineers. Eads Bridge is a National Historic Landmark.

It appears now that the sturdy old bridge will get another life. The bridge, and a 4,000-ft-long railroad tunnel extending beneath downtown St. Louis are important elements of the projected St. Louis metropolitan area rapid transit system.

GEOLOGY

The Eads Bridge stonework, measuring nearly 70,000 cubic yards, offers an excellent opportunity to examine several different rock types, each chosen to best serve a specific function.

The best stone available for construction of bridge piers is tough, durable granite. It is especially well suited for use at the water line where abrasion and the action of water and ice is liable to cause rapid disintegration. Eads Bridge piers and abutments are faced with gray granite (Devonian), quarried in Maine and Virginia. Both fine-grained and coarse-grained varieties were used. Only after the contracts had been signed was it discovered that Missouri red granite from the St. Francois Mountains area would have been just as suitable at less cost.

Graniteville Granite (Precambrian), commercially known as "Missouri Red," was used by Eads to face the bases (up to high-water mark) of the approach-support arches which span the levee (fig. 16). The coarsed-grained red stone came from the Ozark Mountain Quarry at Graniteville in Iron County. Opened in 1869, this was the state's first granite quarry. The granite stonework in Eads Bridge is all coursed ashlar.

Figure 16. Eads Bridge stone-arch bases on levee are faced to high-water mark with 26-inch-high ashlars of red Graniteville Granite; remainder of arched stonework is Aux Vases Sandstone. Photo by Art Hebrank.

The cores of the piers and abutments (not visible) are giant blocks of Joliet dolomite (Silurian), quarried at Grafton, Illinois, about 40 miles upriver from St. Louis. During pier construction, when operating at full capacity, workmen could lay about 10,000 cubic feet of masonry a day. Some of the dolomite blocks weigh as much as seven tons.

When selecting stone for bridge construction, strength and durability are of utmost importance. Stone used should be thick-bedded, homogeneous, and free of internal bedding planes. Two very different kinds of stone, both generally fitting these specifications, were used to build the arches and walls supporting the Eads Bridge approach on the St. Louis side of the river.

The series of high arches that span the levee are constructed (above high-water mark) of massive, fine- to very fine-grained, tan-colored Aux Vases Sandstone (Mississippian). The stone was quarried just south of Ste. Genevieve, Missouri, and barged 60 miles upriver to St. Louis.

The sandstone ashlars were dressed (hewn) to flat faces with hammers, chisels, and points. Each block was first drafted--a border was chiseled around the face (in this case with a toothed chisel). The area within was then dressed to a level with the draft, with a point and hammer. This "pointed work" and "drafted margin" are still readily visible on many Eads Bridge Aux Vases Sandstone blocks (fig. 17).

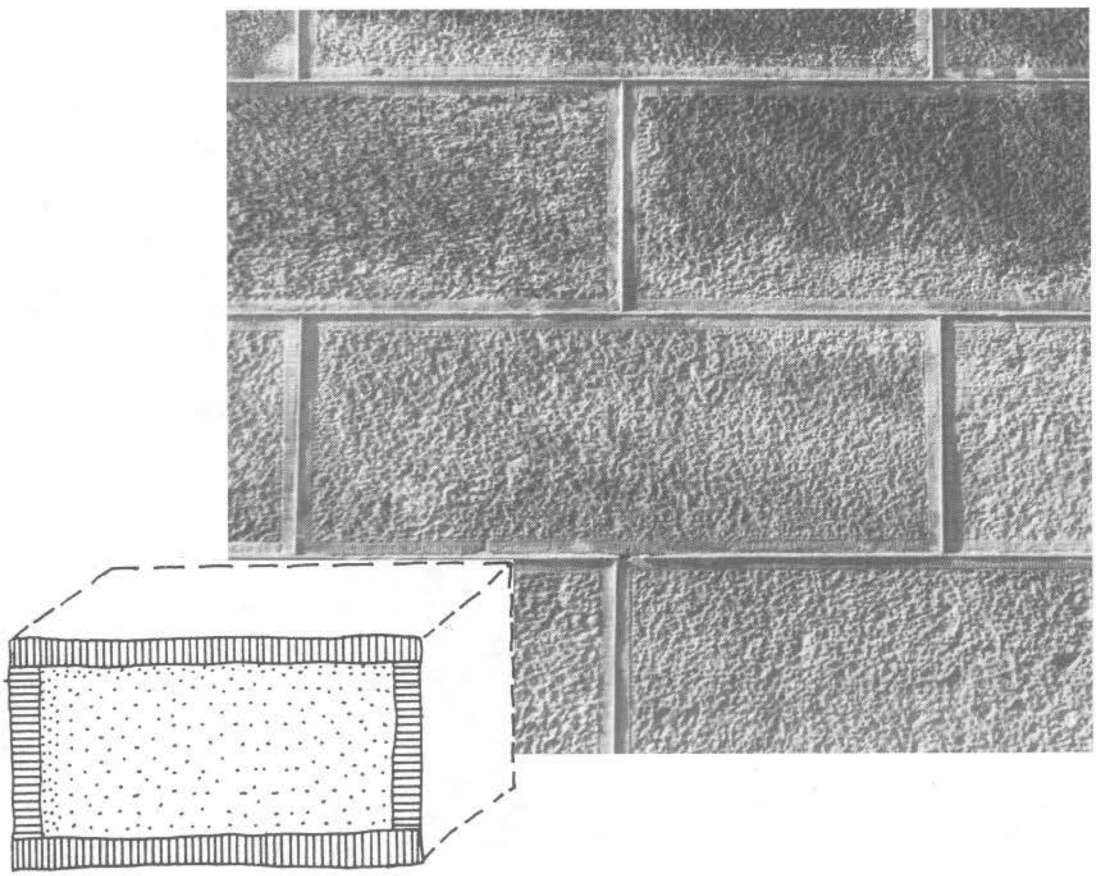


Figure 17. Hand-hewn "drafted margins" and "pointed work" are clearly seen on unweathered faces of Aux Vases Sandstone ashlars in Eads Bridge. These 28-inch-high blocks are in the south wall of the stairway and elevator tower on Washington Avenue, just west of the levee. Photo by Art Hebrank.

The Aux Vases is the only stonework in the bridge that shows significant deterioration. Surface weathering appears to be most severe in areas of high-moisture retention.

Most of the walls and arches supporting the approach back from (west of) the levee are Joliet dolomite (Silurian), quarried at Grafton, Illinois. This massive, very fine-grained, buff-colored stone is the same as that in the cores of the bridge piers. The high, arched, load-bearing walls are coursed ashlar for maximum strength; the walls enclosing some of the arches are structurally unimportant, so less-expensive random ashlar masonry was used (fig.18).

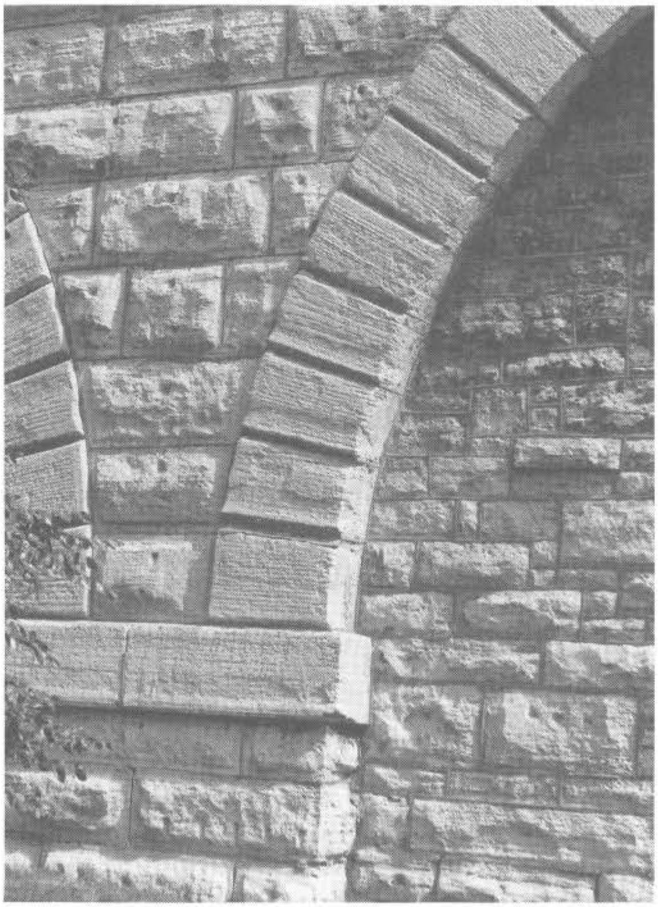


Figure 18. Joliet dolomite coursed ashlar and random ashlar masonry in Eads Bridge approach wall on Washington Avenue, just east of North First Street. Courses between two arches average 18 inches high; random ashlars in arch range from 4 to 18 inches high. Photo by Art Hebrank.

5. LACLEDE'S LANDING/STONE STREETS

HISTORY

In December 1763, Pierre Laclede, a 40-year-old Frenchman, and Auguste Chouteau, a 14-year-old native of New Orleans (and Laclede's common-law stepson), landed at a site about 600 yards south of here (near the Gateway Arch) and founded the City of St. Louis. It was not a happenstance city, but was carefully planned from the very beginning. Laclede and a wealthy partner had been granted exclusive trading rights with Indians of the Missouri Valley. When they chose the site for their trading post, they paid careful attention to commercial advantage and potential for permanence. They selected a rocky eminence on the riverfront, just a few miles south of the junction of the two great rivers.

In 1764, Laclede laid down plans for the streets of the new village; it extended 11 blocks along the river but only three blocks deep. A map drawn by Chouteau shows that by 1780 the fledgling town had already grown to 19 blocks long (fig. 19). The city prospered and grew, and the riverfront area developed into the city's commercial center. As St. Louis assumed a more industrial character,

Figure 19. Map of St. Louis in 1780; redrafted from Auguste Chouteau's 1825 original for Campbell's Gazetteer of Missouri, 1874. The nine blocks now called Laclede's Landing have been shaded.

foundrys, mills, and manufactories shared space with a variety of shops, businesses, and residences. The old narrow streets were always crowded, and echoed the hollow "chatter" of wagons and carts hauling all sorts of wholesale and retail goods.

With the decline of riverboat shipping in favor of rail haulage, and later, the increased mobility afforded by motor vehicles, the business district of the city moved back from the river. Once-proud commercial buildings were converted to warehouse space or allowed to fall into disrepair.

After 40 blocks of buildings were razed in the late 1930s for development of the Jefferson National Expansion Memorial Plaza, the area known today as Laclede's Landing was all that remained of the early French village (fig. 19) and the St. Louis riverfront commercial district. Laclede's Landing is a nine-block area located between Eads Bridge and the Martin Luther King Memorial Bridge, and extending from the river to North Third Street (fig. 20). In 1974, the buildings of the landing were 95 percent vacant.

In 1975, the Laclede's Landing Redevelopment Corporation, a group of local businessmen and property owners, was granted approval by the city to rehabilitate the historic riverfront area. Work began in 1976. Old buildings were cleaned up and renovated, but original architectural character was retained. To date, about $100 million has been invested, almost all of it private capital.

The area now boasts more than one half million square feet of office space; nearly 30 restaurants, cafes, and clubs; two hotels; a bank: and a variety of interesting shops and entertainment facilities. More than 1500 people are employed in the area, and the Landing hosts more than 2 million visitors annually.

Most importantly, while Laclede's Landing is providing St. Louis residents and visitors with places to work and a good time, it is also preserving a small segment of our heritage. In 1976, Laclede's Landing was designated a National Landmark and listed in the National Register of Historic Places.

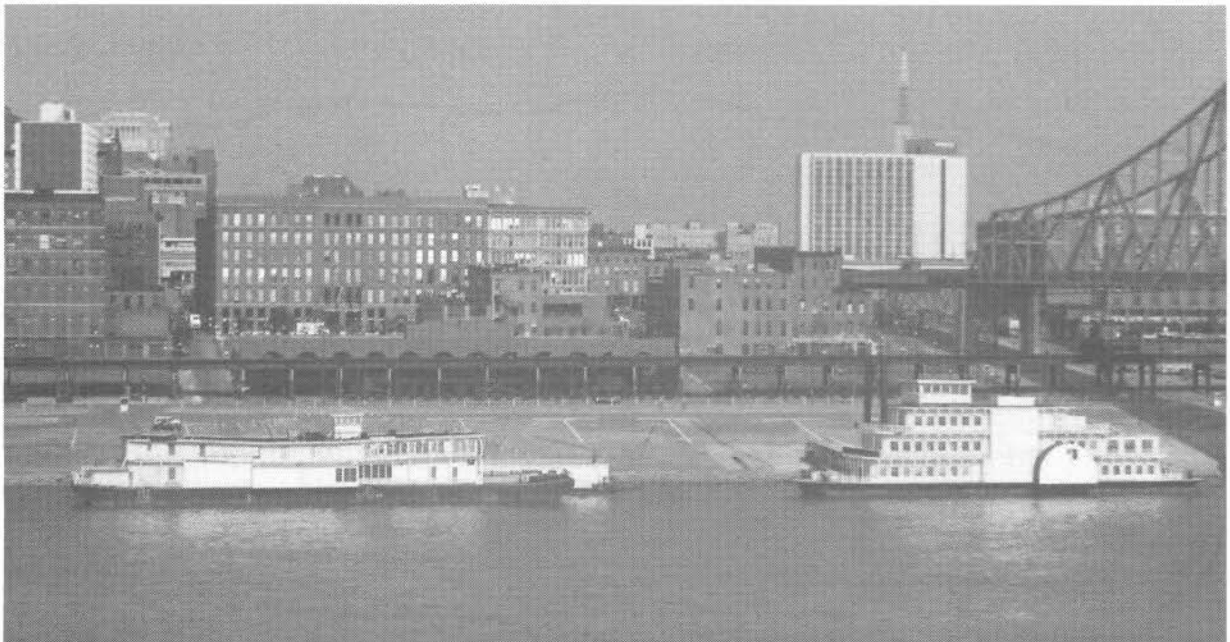


Figure 20. The Laclede's Landing historic district viewed from Eads Bridge. Photo by Art Hebrsnk

GEOLOGY

An important part of renovating Laclede's Landing was restoration of the stone-block street pavements. In 1976-77, asphalt surfacing was removed to uncover the old paving blocks. As at the levee, most of the "pavers" are made of granite and other Precambrian igneous rocks quarried in southeast Missouri (fig. 21).

The intersection of North First Street and Lucas is a good place to examine more paving blocks and discuss how the "pavers" were laid.

Paving blocks are laid on a 2- to 3-inch cushion of fine, dry, angular sand which in turn rests on a thicker foundation of coarser sand or (better yet) concrete (fig. 22). The blocks are set level using a string line stretched from curb to curb, "rammed" into place using a 60- to 70-pound ramming rod, then adjusted for proper position. Lastly, the joints between the blocks are filled with sand, hot tar, or cement to hold them firmly in place.

Stone "pavers" were always laid with the long dimension perpendicular to the direction of traffic. This gave horses better footing, wagons didn't slip sideways as easily, and the pavement didn't rut or wear as bad.

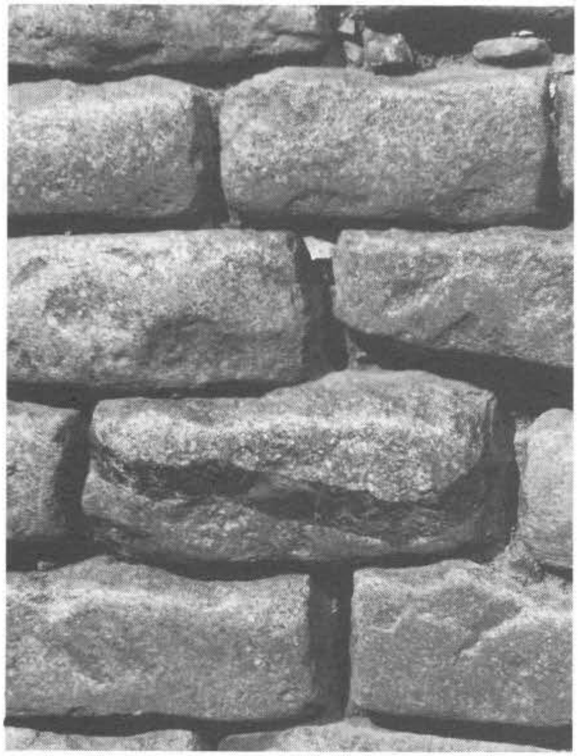
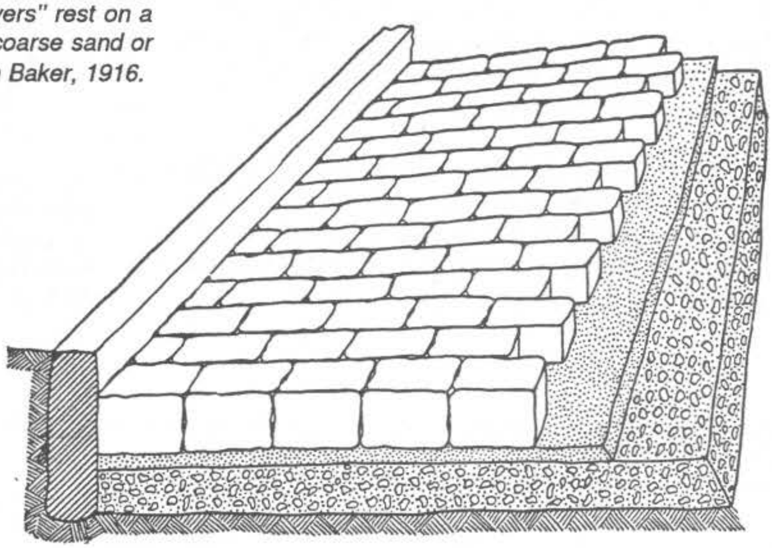


Figure 21. Well-worn Missouri granite paving blocks on Morgan, just east of North First Street. The 121/2 x 5 inch block near the center is red granite cut by a black basalt dike. Photo by Art Hebrank.

Figure 22. Diagram illustrating proper construction of a stone block street pavement. "Pavers" rest on a cushion of fine sand spread on a coarse sand or concrete foundation. Modified from Baker, 1916.



At intersections, blocks are characteristically laid diagonally, the most common arrangement being the double-diagonal pattern (fig. 23). Laclede's Landing intersections were originally laid out in that pattern. They were modified, as seen at this intersection, for visual effect and to better accommodate handicapped (and non-handicappedl) pedestrians.

A properly constructed street includes curb as well as the pavement surface. Curbing should be made of hard durable stone to avoid abrasion and water damage; granite is probably best. Missouri granite (Precambrian) and Georgia granite gneiss (Pennsylvanian) curb- stone was used extensively in St. Louis' newer downtown area (above Fourth Street); much of it is still in use today.

Sedimentary rock usually makes poor curb-stone. When it is used, the beds of rock are stood on edge. This exposes the bedding planes to weathering, and the curbs are liable to split apart. Nevertheless, in the years before granite curbing became popular, a large amount of St. Louis Limestone (Mississippian) was used for curbing on St. Louis streets. It was readily available, cheap, and easy to install.

Most curbing in Laclede's Landing is new concrete, but some old curbstone remains in use. The best example is on the south side of Lucas, just west of North Second Street (fig. 24). Most of this old curbing is St. Louis Limestone. While some sections have been damaged by splitting, others appear to be relatively sound. The few granite curbstone sections here were probably installed to replace damaged limestone.

Near the old curbstone, a small area of Lucas Street is surfaced with gray granite gneiss paving blocks, probably from Georgia (Pennsylvanian). These are slightly smaller than typical Missouri red granite "pavers" and not as well formed.

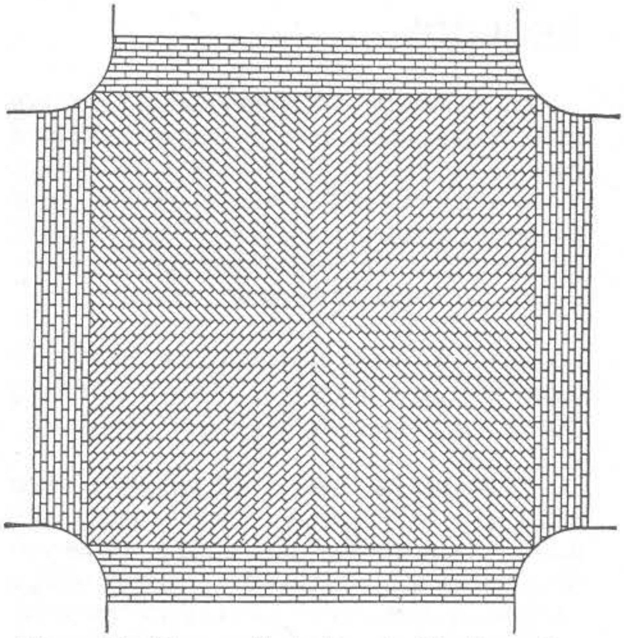


Figure 23. Diagram Illustrating double-diagonal arrangement of stone paving blocks at an intersection. Modified from Baker, 1916.

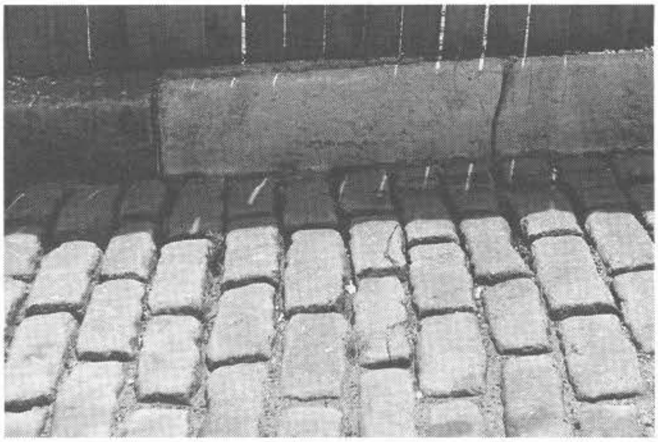


Figure 24. Stone curbing along south side of Lucas, just west of North Second Street. Most of the curbing is St. Louis Limestone: the darker colored replacement section on the left is granite. Photo by Art Hebrank.

6. BRICK/CLAY INDUSTRY

HISTORY

Most of St. Louis' early frontier buildings were Creole French-style palisadoed log houses--logs were set vertically, "plastered" with tempered mud or clay, and whitewashed. A few of the earliest residences and businesses were built of St. Louis Limestone rubble. Brick houses were introduced to St. Louis by eastern U.S. Americans who moved here after the Louisiana Purchase; they soon changed the character of the town.

A kiln of brick was advertised for sale in the *Missouri Gazette* of October 12, 1811, and the city's first brick building was constructed on Main Street (First Street) the following year. By 1818, St. Louis had at least two important brick buildings, the first Catholic cathedral and a Baptist church. In 1839 an ordinance was passed to prevent the building of frame or log structures in the riverfront area; it specifically required the use of brick or stone. Brick construction continued to increase in favor through the late 1800s, and by the turn of the century St. Louis sported many fine brick residences and commercial buildings.

The buildings still standing in the Laclede's Landing area range in age from pre-Civil War to the early 1900s. The major construction material is brick, and even a casual examination reveals a variety of architectural treatments of the medium. While simple brickwork predominates, tasteful "fancy work" is much in evidence. Arched window openings, brick pilasters, and stepped-brick cornices memorialize the talents and skills of several generations of St. Louis architects and brick masons.

Brick was invariably used in conjunction with other construction materials, most notably cast iron (discussed at Stop 7) and stone. Virtually all brick structures in the area were built on foundations of locally quarried St. Louis Limestone (fig. 25), and many utilize limestone sills or lintels in window and door openings.

Figure 25. Common building brick on foundation of St. Louis Limestone, north side of Lucas Street just west of Clamorgan. Foundation blocks are 8 inches high. Photo by Art Hebrank.

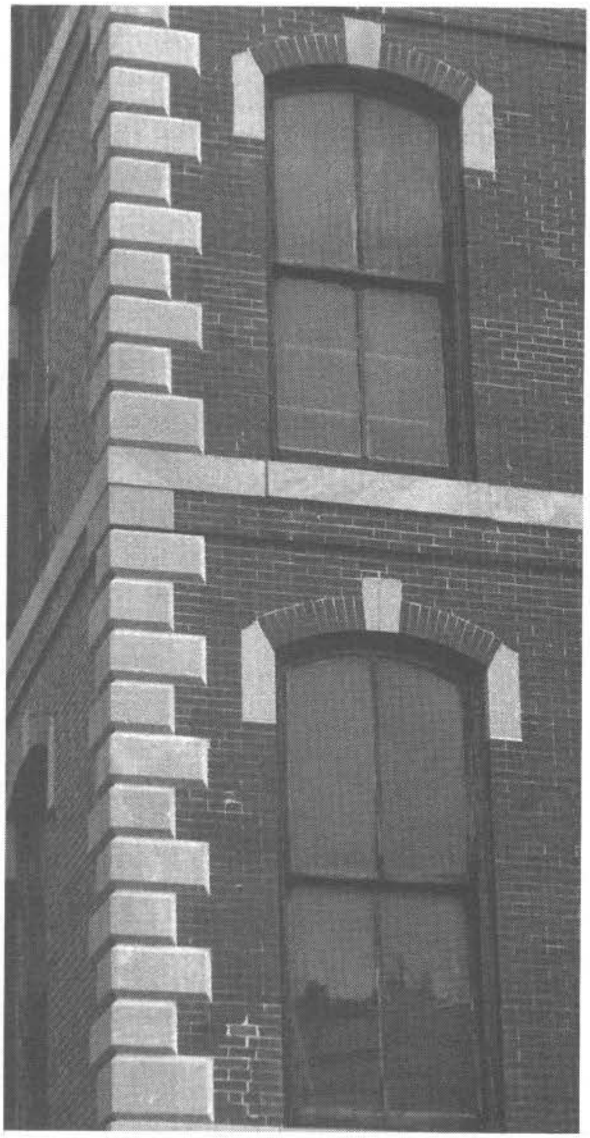


Figure 26. Decorative stone elements in the brick Greeley building, North Second and Lucas Streets. The large corner blocks and the window-arch "keystone" and "kneeler" blocks are Salem Limestone ("Indiana Stone"). Photo by Art Hebrank.

The Greeley Building (a grocery warehouse built in 1880-81), facing on North Second Street at Lucas and extending east to Clamorgan, is a five-story brick structure with bold, limestone-block corner and window trim (fig. 26). The limestone appears to be "Indiana Stone" (Mississippian Salem Limestone). Two loading docks on Lucas, just west of Clamorgan, feature wear-resistant decks of dense gray St. Louis Limestone.

Several buildings in the district combine fancy brickwork with structural or ornamental cast-iron elements. The small building at 720-22 North First Street is a charming example (fig. 27).

Ornate terra cotta (hard, burnt clay) trim was widely used in turn-of-the-century St. Louis buildings. Some brick buildings in the Landing area were decorated with terra cotta, but all are now razed and no examples remain.

Laclede's Landing crosswalks, and the decorative Clamorgan walkways on either side of Lucas Street, are paved with brick (fig. 28). This particular brick was salvaged from the East St. Louis stockyards during redevelopment, but similar paving brick was used extensively in St. Louis.

The first use in St. Louis of brick made especially for paving was in 1880. An experimental lot of locally manufactured brick (see geology section), financed by $50 contributions from 100 leading citizens, was laid at the west approach to Eads Bridge. Very quickly the bricks wore out and broke up under the severe traffic of the East St. Louis freight wagons, probably the heaviest in the area. There were other experiments, some successful, but no wide-spread use until 1895 when the city adopted brick for use in alleys and on residential streets.

The brick "pavers" decoratively laid in Laclede's Landing are typical of those used on St. Louis streets. Patterns or names, either embossed or incuse, are often moulded on the sides of paving brick; these ridges and grooves key into the grout and help hold the brick in place in the pavement. The bricks at Laclede's Landing have been laid with their sides upward, for increased traction and decorative effect.

Figure 27. Cast-iron "keystones" and pilaster "capitals" complement the fancy brickwork of the second-floor facade at 720-22 North First Street. The ornate window cornices on the third floor (not in picture) are also cast iron. Photo by Art Hebrank.

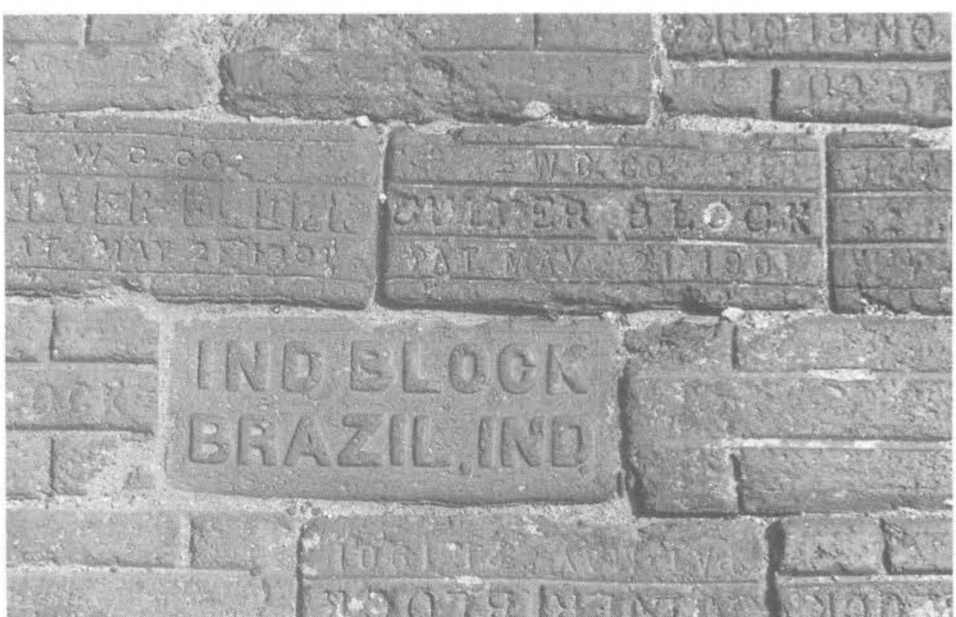


Figure 28. Detail of paving brick on Clamorgan walkway, just south of Lucas Street. Exposed faces (sides) of bricks are 9x4 inches. Photo by Art Hebrank.

GEOLOGY

The natural abundance of several types of clay in St. Louis, and the demands of an emerging metropolis for cheap construction materials, combined to make the city a major manufacturer of clay products.

Most of the common building brick manufactured in St. Louis is made from loess (Pleistocene), a silty clay deposited by wind following retreat of continental glaciers during the great ice ages. Loess is abundant throughout the city, mantling bedrock everywhere; it is usually thickest on the bluffs and uplands immediately adjacent to the river. Loess is commercially known as "yellow clay" or common brick clay, and much of it has the proper natural composition for brick making. In the formative years of the brick industry, clay was wet tempered and moulded by hand, then kiln baked.

The Hydraulic Press Brick Company, organized in 1868, was the first plant west of the Allegheny Mountains to manufacture machine-made brick; annual capacity was 8 million bricks. By 1894, the company was operating six brickyards in the city, and their dry-press brick machines (fig. 29) were producing more than 100 million bricks annually. The high-quality St. Louis press brick became a standard nationwide. At the turn of the century, the Hydraulic Press Brick Company, with branch yards in several U.S. cities, was the largest brick maker in the world!

St. Louis was never an important producer of paving bricks, but she did play a significant role in their early development. One of the first efforts in the United States to make a brick especially adapted to street paving was by George Sattler, about

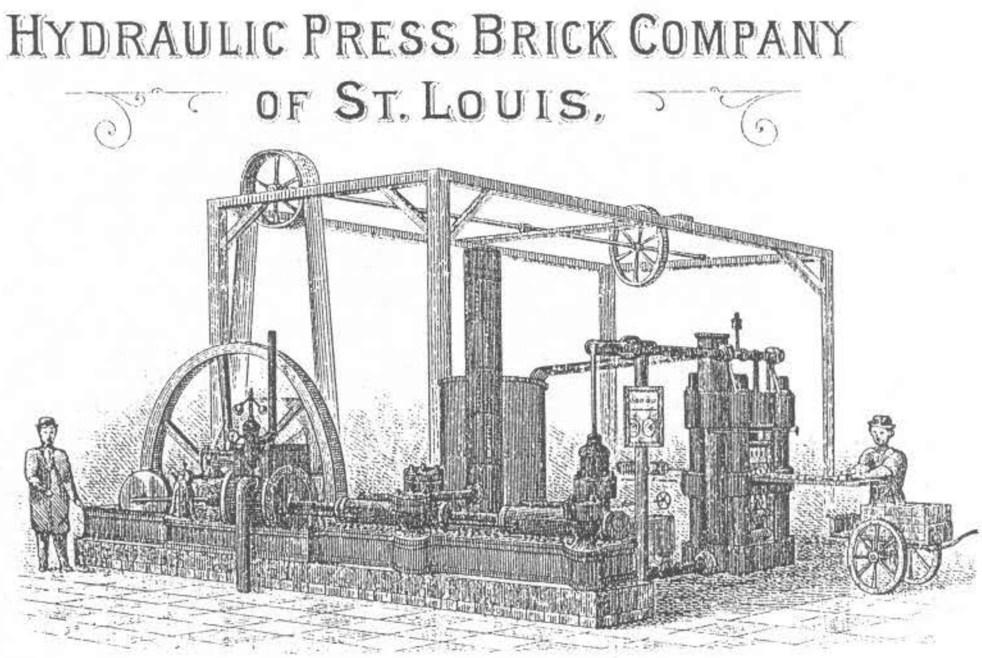


Figure 29. Press-brick machine. Vignette from 1880 letterhead of J. J. Lockwood, sole Chicago agent for the Hydraulic Press Brick Company of St. Louis. Courtesy Jack Beamer, St. Louis.

1876. Sattler's bricks were large blocks, 9 x 4 x 5 inches, hand moulded from fireclay (Pennsylvanian) mined in north St. Louis County. His first experimental pavement, laid at the approach to Eads Bridge in 1880, was a failure, but with persistence he eventually developed and patented a process for making a good-quality paving brick.

The brick used for paving, called "vitrified brick," is burned so hard as to be very dense, extremely hard, and almost non-porous. The best vitrified brick is made from shale or impure clay; the high-quality fireclay mined so extensively in St. Louis was not well suited. Virtually all paving bricks used in St. Louis were made from shales (Pennsylvanian), in central or western Missouri or in nearby midwestern states.

Brick "pavers" were laid in all respects like stone paving blocks (Stop 5), except they were not "rammed" but rolled into place with a steam roller. Brick was the ideal pavement for light-traffic streets, on account of its low initial cost, cheap maintenance, good traction, cleanliness, and slight noise.

While none of the products are seen in the riverfront area, St. Louis hosted, from 1850 to about 1950, a major clay-products industry, founded on the celebrated Cheltenham clay (Pennsylvanian). Most production was from south-central St. Louis, and St. Louis County. Firebrick and other refractory products were made from the best-quality fireclay; poorer clays were used to manufacture sewer pipe, ornamental brick, and decorative terra cotta.

The stature of St. Louis' clay-products manufactories is told by the fact that in 1894 she was home to the largest press brick, fire brick, sewer pipe, and terra cotta factories in the United States.

7. IRON-FRONT BUILDINGS/IRON MINING

HISTORY

A fire that started on a steamboat in May 1849 quickly spread through a large section of the St. Louis riverfront district and ultimately destroyed 15 blocks and 430 buildings. Almost immediately, massive, rapid rebuilding took place, made possible by extensive use of iron structural members and prefabricated iron fronts for buildings--most of them manufactured in St. Louis. Not only were the iron fronts speedily erected, they were cheap. The *St. Louis Weekly Reveille* for August 13, 1849, carried an advertisement offering "cast iron store fronts consisting of pillars, etc. for $3.50 to $4.00 per 100 pounds, set up on the job." The iron foundry business flourished, and very quickly the city became a leading producer of architectural iron, a position it held for several decades.

Designing and fabrication of ironwork for buildings was at its peak in St. Louis from 1855 to 1861; as many as 30 foundries were in production at one time. Early St. Louis architects utilized the new medium extensively, and before long St. Louis' iron fronts rivaled, both in quantity and quality, those of New York City's famed cast-iron district. Wide use of architectural iron continued into the 1880s.

The St. Louis commercial district, in its heyday, included some of the finest examples of iron-front buildings anywhere in the United States. Most of them were destroyed in clearing for the Jefferson National Expansion Memorial Plaza; just a few remain today. Several of the best are in Laclede's Landing.

Architectural historians consider the Raeder Building (fig. 30), on the southwest corner of North First Street and Morgan, to be the finest surviving cast-iron front in St. Louis, and nationally significant. It was designed by Frederick William Raeder and built for the Christian Peper Tobacco Company in 1873-74. The six-story iron front is elegantly simple, with restrained detail (fig. 31); it features an extraordinary proportion of window area for the period. The north wall (on Morgan) is brick with stone trim. The ashlar foundation stone and basement-window lintels are St. Louis Limestone; the arched brick windows are set with "Indiana Stone" sills. Before the Raeder Building, this was the site of the Missouri Hotel, 1820 meeting place of the First General Assembly of Missouri.

The simple, three-story iron front (fig. 32) at 714-16 North Second Street, just south of Morgan, is also noteworthy. The name of the foundry, T.R. Pullis & Bro., is cast in the ironwork (fig. 33), just above sidewalk level. Thomas R. Pullis, in partnership with several different family members, headed one of St. Louis' earliest and most important foundries that produced architectural iron from 1839 into the twentieth century. This iron front was manufactured sometime between 1867 and 1873.

The Witte Hardware Building is a simple brick structure on the west side of North Second Street, between Morgan and Lucas. Tasteful conversion to office space has provided access to interior structural elements; a six-story, skylighted atrium shows off the wooden post- and-beam superstructure, held together by simple cast-iron joints (fig. 34). The Witte Building, designed by Ernst C. Janssen, was built in 1905.

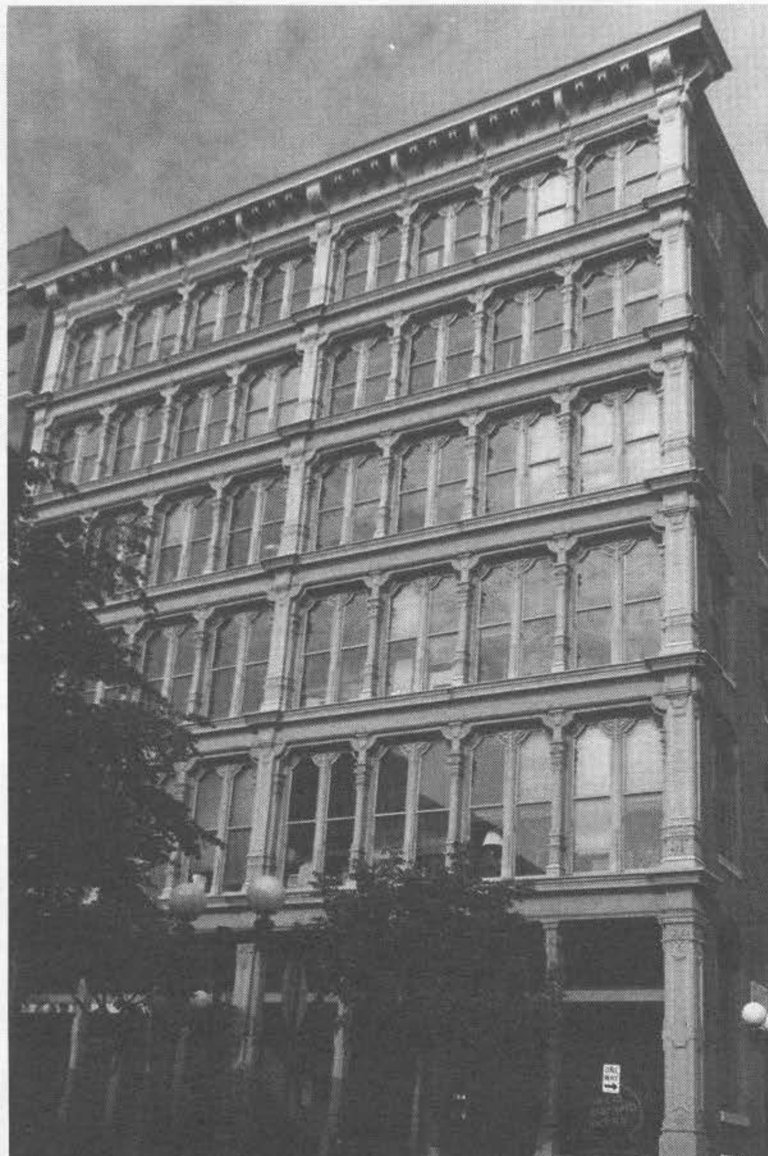


Figure 30. The six-story Raeder Building, built 1873-74, on North First Street at Morgan, is considered the best surviving cast-iron front in St. Louis, and of national significance.

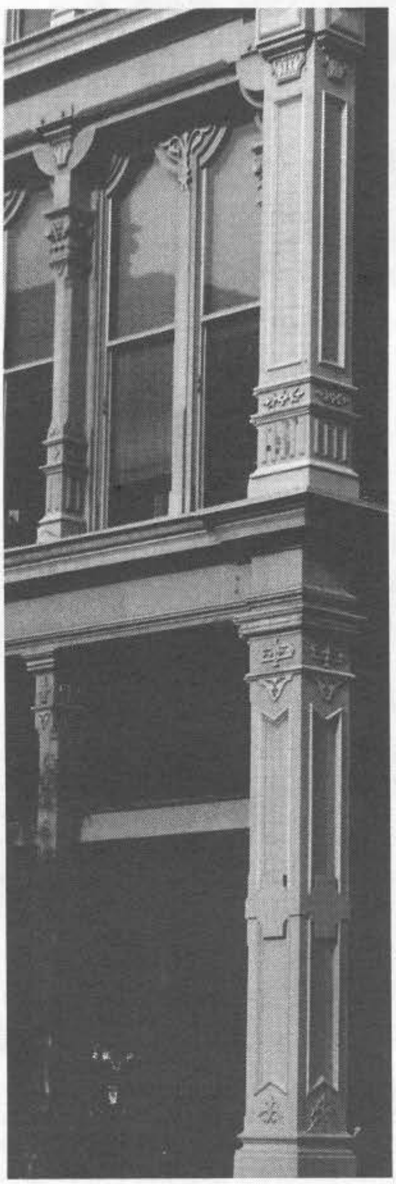


Figure 31. Corner detail of Raeder building exhibits the restrained ornamentation typical of St. Louis iron fronts. Photos by Art Hebrenk.

Figure 32. Ground floor of simple iron-front building at 714-16 North Second Street, just south of Morgan. Photo by Art Hebrank.

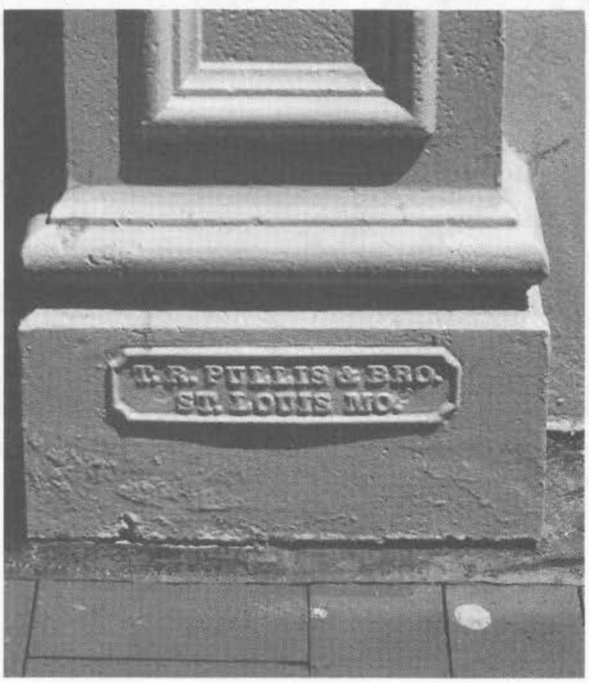


Figure 33. "T.R. Pullis & Bro." nameplate, cast in ironwork (just above sidewalk level) of the building pictured above. Photo by Art Hebrank.

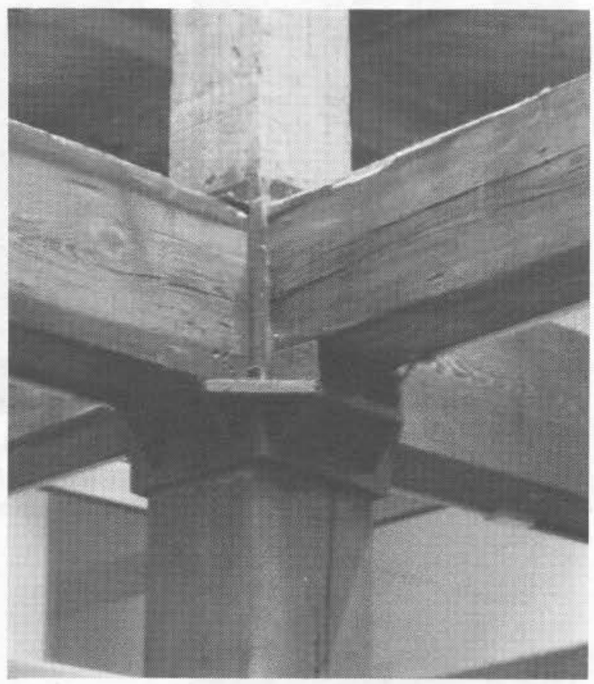


Figure 34. Simple cast-iron "knuckle" joining wooden post and beam superstructure of the Witte Building, 705-19 North Second Street. Post is about 14 inches square. Photo by Art Hebrank.

GEOLOGY

St. Louis' importance as an iron manufacturing center was due in part to the nearby occurrence of high-grade iron ore. Much of the production of important early mines and furnaces in central and southeast Missouri was delivered to the St. Louis trade. Some mines were owned and operated by St. Louis corporations.

A significant early supplier was the Maramec Iron Works (fig. 35), near St. James (Phelps County), 90 miles west of St. Louis. Established in 1826 by Thomas James and Samuel Massey, Maramec was the first economically successful iron works west of the Mississippi River. Most of the hematite iron ore used here was mined by

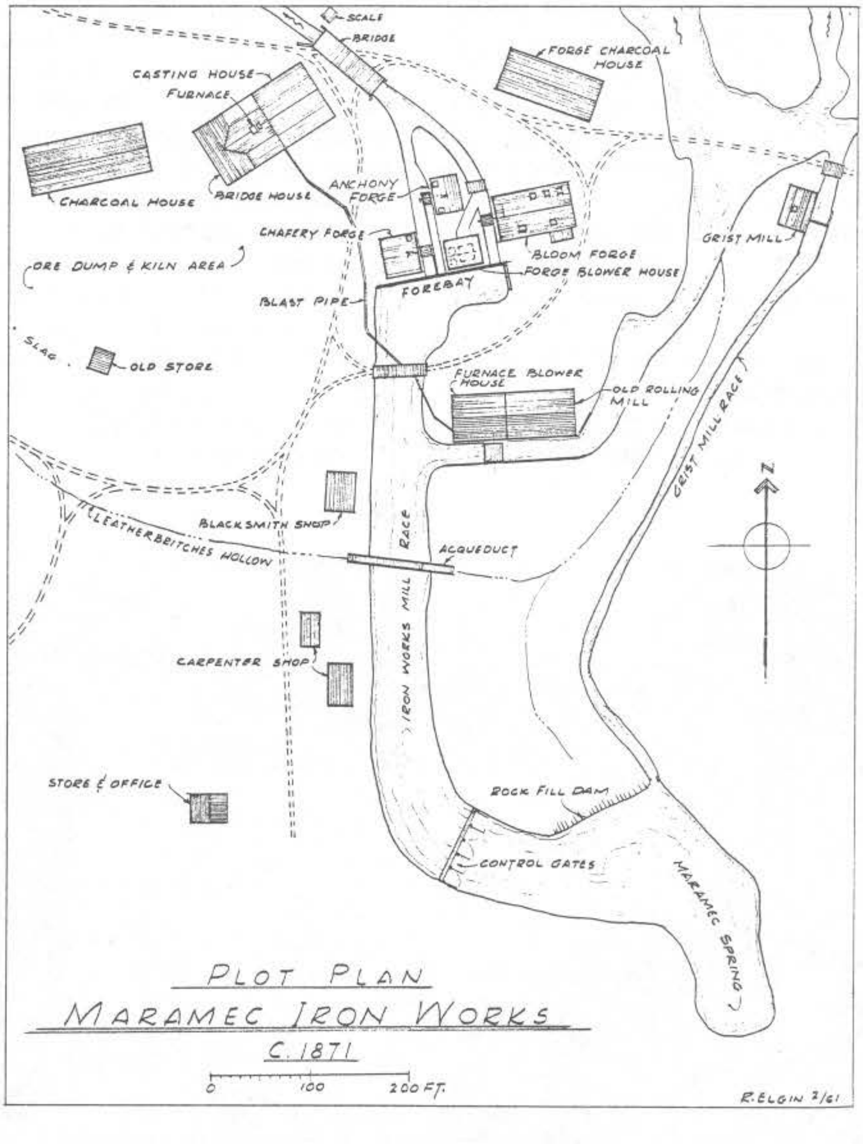


Figure 35. Map of major buildings and structures at the Maramec Iron Works, circa 1871; mapped and reconstructed by Robert Elgin, 1961. Maramec was established in 1826 as a self-contained iron plantation and produced pig and wrought iron until 1876. Courtesy Robert Elgin, St. James, Missouri.

open-pit methods from a large filled-sink deposit in the Gasconade Dolomite (Ordovician). When operating at full capacity, the cold-blast charcoal furnace produced 14 tons of pig iron each day; some of this was hammered into wrought iron.

Business boomed through the Civil War years. Maramec iron was used almost exclusively for armor plate on a Union Army flotilla built in 1862 by James Eads, later of Eads Bridge fame. At his Carondelet (south St. Louis) shipyard he built seven ironclad gunboats (in 65 days!), which made possible the capture of Island Number 10 in the Mississippi and U.S. Grant's victories at Forts Henry and Donelson on the Tennessee, and broke the Confederate grip on the lower Mississippi. When business slumped after the Reconstruction years, Maramec was unable to compete with "modern" hot-blast, coal-fired furnaces or with rolling mills, and shut down in 1876.

The mine, restored furnace and forges, an interpretive center, and the giant spring (96 million gallons per day average flow) that provided power for the iron works, are the featured attractions of a beautiful, privately owned park administered by the James Foundation of New York. Maramec is open daily to visitors.

The most important early supplier of iron to St. Louis was the celebrated Iron Mountain Mine (first organized as the Missouri Iron Company, fig. 36), about 80 miles south of the city. This deposit was generally believed to be a "mountain of nearly pure iron" and was once described as "virtually inexhaustible, able to supply the needs of the entire world for 1,000 years"! The American Iron Mountain Mining Company, headed by millionaire St. Louisan James Harrison, commenced operations in 1843. High-grade hematite-magnetite ores were produced from a thick sequence of rhyolitic volcanic rocks (Precambrian), with open-pit and underground mining methods. The St. Louis and Iron Mountain Railroad, completed in 1858, was built to facilitate shipment of iron, and later ore, to the city. Production of ore by a succession of companies was almost continuous until 1966. During its 123 years of operation, the property yielded nearly 9 million long tons of iron ore concentrates.

Figure 36. Certificate for 1000 shares of capital stock in the Missouri Iron Company, incorporated in 1836. This was the predecessor of the Missouri Iron Mountain Mining Company, headed by St. Louisan James Harrison.

8. OLD COURTHOUSE/MASONRY AND MARBLE

HISTORY

In St. Louis' early years, court was convened (when deemed necessary) in a variety of inadequate, unlikely quarters, including abandoned cabins or houses, a Baptist church, and a tavern. In 1826-28 a two-story brick courthouse, with cupola and plastered brick columns, was built on the courthouse square, a block of land formerly part of the old St. Louis common field. It was undeniably the most elegant public building in the state, in spite of its undistinguished site--virtually out of town, four blocks back from the river.

Construction of a larger Courthouse commenced in 1839. Plans called for a monumental, four-winged, Greek Revival structure with a large rotunda centered beneath a low dome (fig. 37); the old brick Courthouse was incorporated as the east wing. The project did not proceed smoothly, but the more-or-less completed Courthouse officially opened anyway in 1845.

In 1851, a new plan was adopted and workmen were once again on the site. It was decided to replace what was left of the original brick Courthouse and significantly enlarge or modify the other three wings. Ultimately the structure would be fitted with a high-arched dome, and the rotunda would be redesigned.

By 1859, the Courthouse had been under construction on and off for 20 years. Public patience was wearing thin and Courthouse "humor" was the order of the day. Sensing that maybe the building was finally almost finished, the editor of St. Louis' *Missouri Republican* in his September 4th issue quipped, "Generations now alive may yet see the Court House completed." The old St. Louis Courthouse, essentially as it stands today (fig. 38), was officially completed in 1862. Total cost of construction was about $1.2 million.

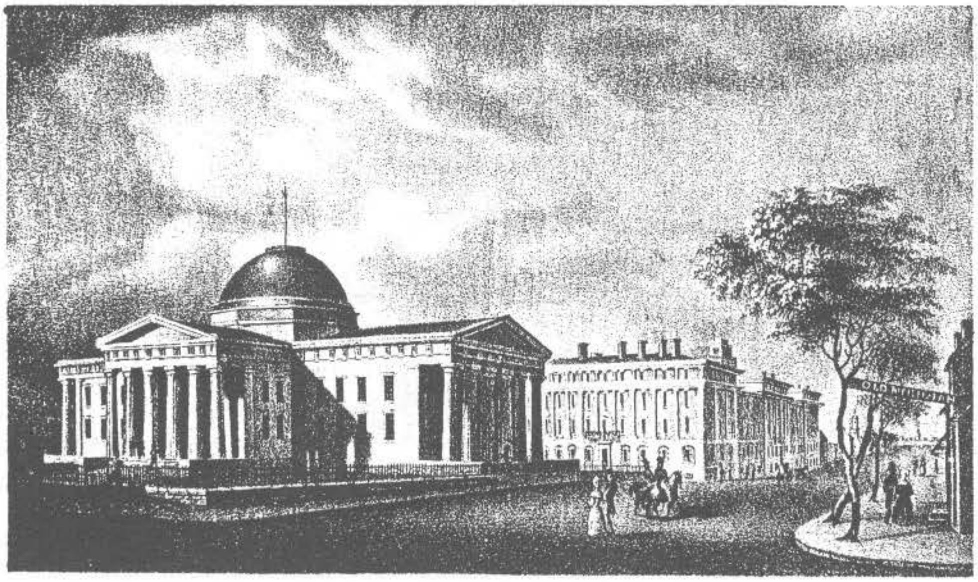


Figure 37. This view of the St. Louis Courthouse, from an 1841 lithograph by J. C. Wild, was probably drawn from an 1839 architect's sketch, as the building never existed in this form. The Courthouse, as completed in 1845, had a low dome, but there were no columned porticoes and the old brick Courthouse constituted the east wing.

The crowning glory of the Courthouse is the graceful, high-arched, Italian Renaissance dome, built in 1860-61. The dome was designed and constructed by William Rumbold, and features a patented wrought- and cast-iron frame. There was much controversy over the merits of the design, but Rumbold proved its strength by building a scale model and successfully loading it with 13,000 pounds of pig iron. This and a similar but larger cast-iron dome constructed at the same time--on the U.S. Capitol--were the first of their type in the United States, and among the first in the world. Many later domes were patterned after Rumbold's design.

The rotunda, towering nearly 180 feet up into the dome, is certainly the most impressive and beautiful part of the Courthouse. Featured are ranks of doric, ionic, and corinthian columns and pilasters, each rank more complex than the one on the level below (fig. 39). The columns that bear structural loads are iron; the merely decorative ones are identical in appearance, but of wood. The walls are painted with large murals depicting historical scenes and personages, and allegorical figures. All artwork was originally designed and executed by noted Western and Indian artist, Charles Wimar and his half-brother August Becker. Only four historical lunettes by Wimar remain, and they are extensively altered. Most of the other murals still existing were painted by Italian muralist Ettore Miragoli in 1880.

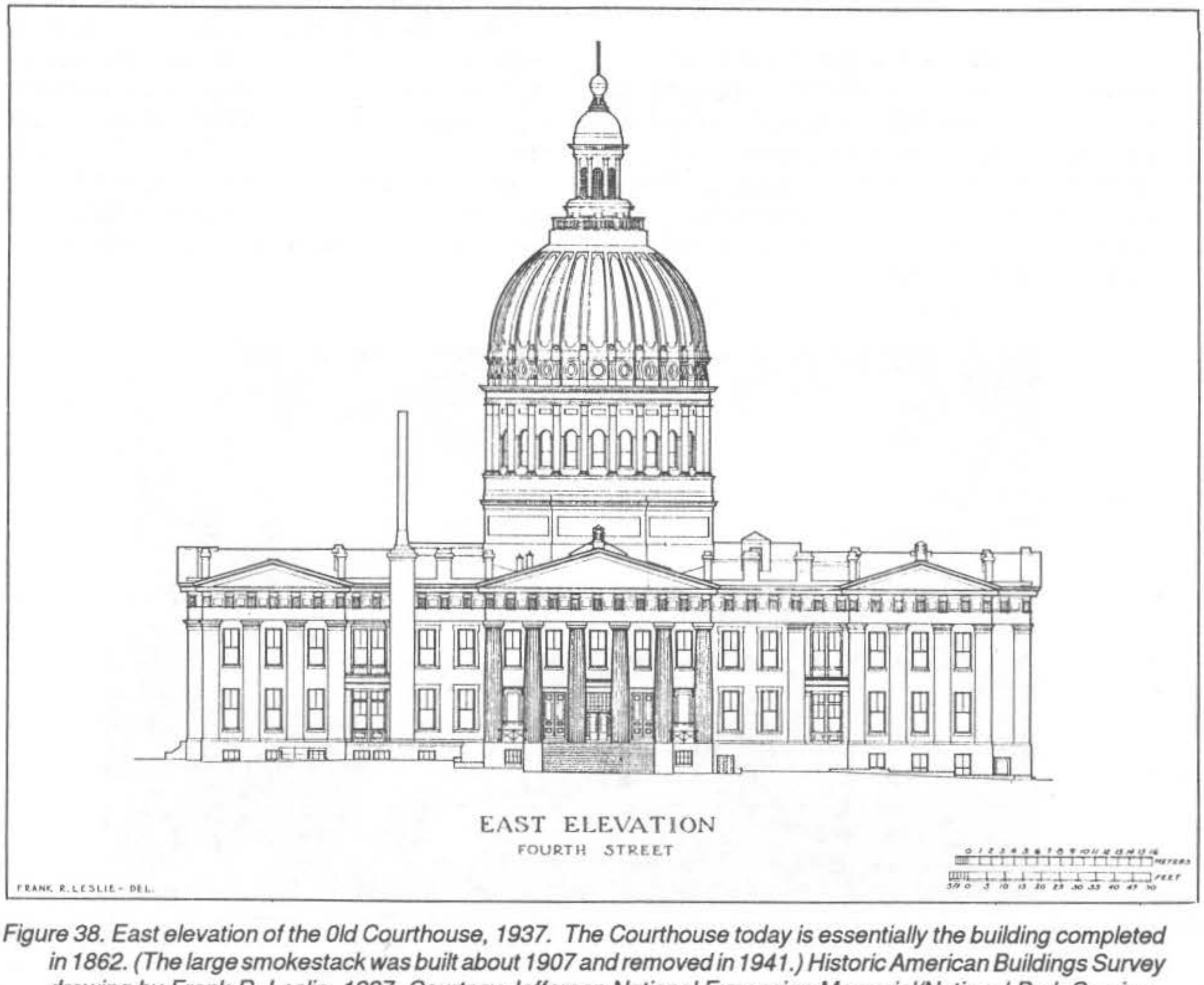


Figure 38. East elevation of the Old Courthouse, 1937. The Courthouse today is essentially the building completed in 1862. (The large smokestack was built about 1907 and removed in 1941.) Historic American Buildings Survey drawing by Frank R. Leslie, 1937. Courtesy Jefferson National Expension Memorial/National Park Service.

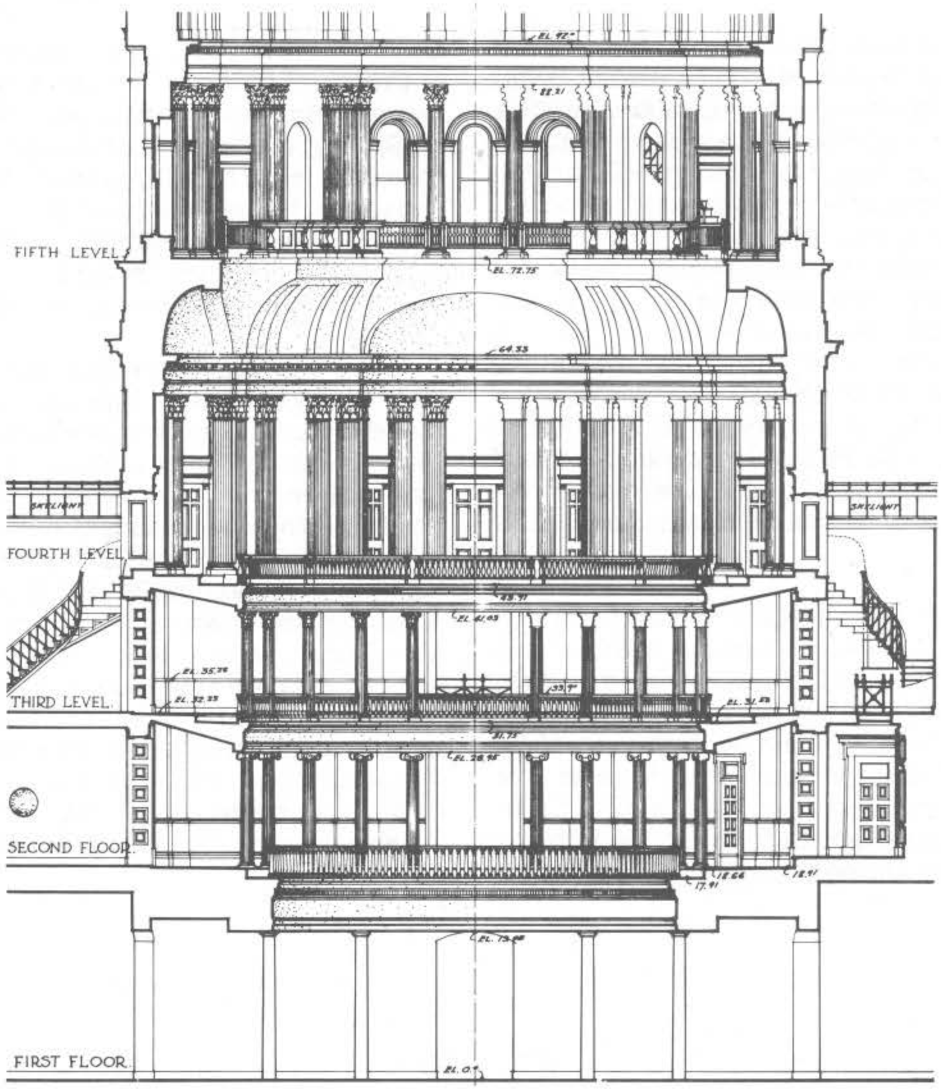


Figure 39. Section through Old Courthouse rotunda, looking south. Ranks of columns and pilasters increase in complexity from the ground floor upward. Historic American Buildings Survey drawing by George Harkness, III and Robert Price, 1934. Courtesy Jefferson National Expansion Memorial/National Park Service.

The upper levels of the Courthouse are reached by several steep iron stairways. Most remarkable is the ornate iron stairway in the east wing. It spirals up 32 feet from the first floor to the third floor, without support from below--all weight is carried by the wall in which it is embedded. Built in 1854, the stairway is still in use today.

Most of the legal decisions handed down during the St. Louis Courthouse's 88 years of active service dealt with strictly local, city or county matters. A few cases involving issues such as slavery, steamboating, or railroad rights had broader significance.

The Dred Scott case was probably the most important ever heard at the St. Louis Courthouse. In 1847, a pair of slaves, Dred and Harriet Scott, filed a rather routine suit for their freedom on grounds of previous residence in free territory. They lost. After appeal, they won their freedom in a second trial here in 1850. Two years later the

Missouri Supreme Court reversed the St. Louis decision and returned the couple to slavery. By this time the litigation was attracting nationwide attention and involved important people with political or ideological interests in the case. In 1857, the U.S. Supreme Court upheld the Missouri decision and offered the opinion that negroes could not be citizens, and slave owners could not be deprived of their property or be prevented from introducing slavery into the new western territories. The implications of the opinion created much furor and widened the rift that several years later led to the Civil War. After the trial, ownership of the Scotts was transferred to the son of a previous owner, and he freed the couple. In 1858, Dred and Harriet Scott registered as free negroes at the St. Louis Courthouse.

For many years the Courthouse was the largest public meeting place in the city, and the center of its social, political, and business life. If anything important was happening in St. Louis, it was probably happening at the Courthouse. In 1847, Doniphan's Missouri regiment of Mexican War volunteers was assembled here, and the Courthouse hosted a grand celebration the following year for the returning heros. Emigrants met at the Courthouse to plan their great cross-country treks to Oregon or California. Important national and regional railroad conventions were held here in 1849, 1852, and 1857. The building's north wing served as the St. Louis City Hall from 1861 to 1873. Repeatedly through the years the walls of the Courthouse resounded with the speeches of the great orators of the day, among them Stephen A. Douglas, Thomas Hart Benton, and Henry Clay.

In 1876, St. Louis City was separated from St. Louis County by the state legislature, and the city gained exclusive jurisdiction over the Courthouse. Official service ended in 1930, when the seat of justice was moved 7 blocks west to the new Civil Courts Building. Recognizing its historical significance, the city deeded the Old Courthouse to the National Park Service in 1940 and today it is a part of the Jefferson National Expansion Memorial. After extensive rehabilitation and renovation, the landmark has once again become an important St. Louis attraction. In addition to the carefully restored rotunda and pair of second-floor courtrooms, it houses the park offices and presents excellent exhibits outlining the history of St. Louis. The Old Courthouse is listed in the National Register of Historic Places.

GEOLOGY

All four wings of the Old Courthouse feature Greek Revival facades; amazingly, each one is different! The east, west, and north wings are dominated by porticoes with massive, fluted columns (fig. 40); the simpler south wing features a rank of square pilasters. The facades are constructed entirely of limestone, while the less important walls are a combination of limestone and brick. All exterior stone masonry is coursed ashlar; some interior basement walls are St. Louis Limestone rubblework.

It was either planned from the beginning, or decided soon after construction, that the Courthouse exterior would be painted -- probably so the building would project a unified, more massive appearance, but possibly to mask visual defects resulting from use of non- uniform and sometimes inferior-quality stone. The Courthouse was first painted in 1864, just two years after dedication. Old records, and microscopic examinations made about 1979, reveal that most of the outside walls were painted at least eight times, and some as many as 20 times. In the early to mid 1980s, the National Park Service restored the exterior of the Old Courthouse, including the paint. Old paint and grime were carefully removed from all brick and stone walls. The surfaces were then sealed and painted using modern epoxy-base and acrylic-emulsion paints.

Unfortunately (for geologists) the superior paint job precludes examination of the limestone. (In two hours I couldn't find even a dime-sized area unpainted!) Park Service restorers, who had access before painting, state that most of the original stone is a crystalline fossiliferous Mississippian limestone, containing numerous unconsolidated (?) fossil shell fragments. In 1961, "Indiana Stone" was used to replace several damaged or deteriorated cornice elements and some slabs on the west portico floor.

Old Missouri Geological Survey reports state that the St. Louis Courthouse columns are Kimmswick Limestone (Ordovician) from a quarry on the Mississippi River, in Jefferson County,

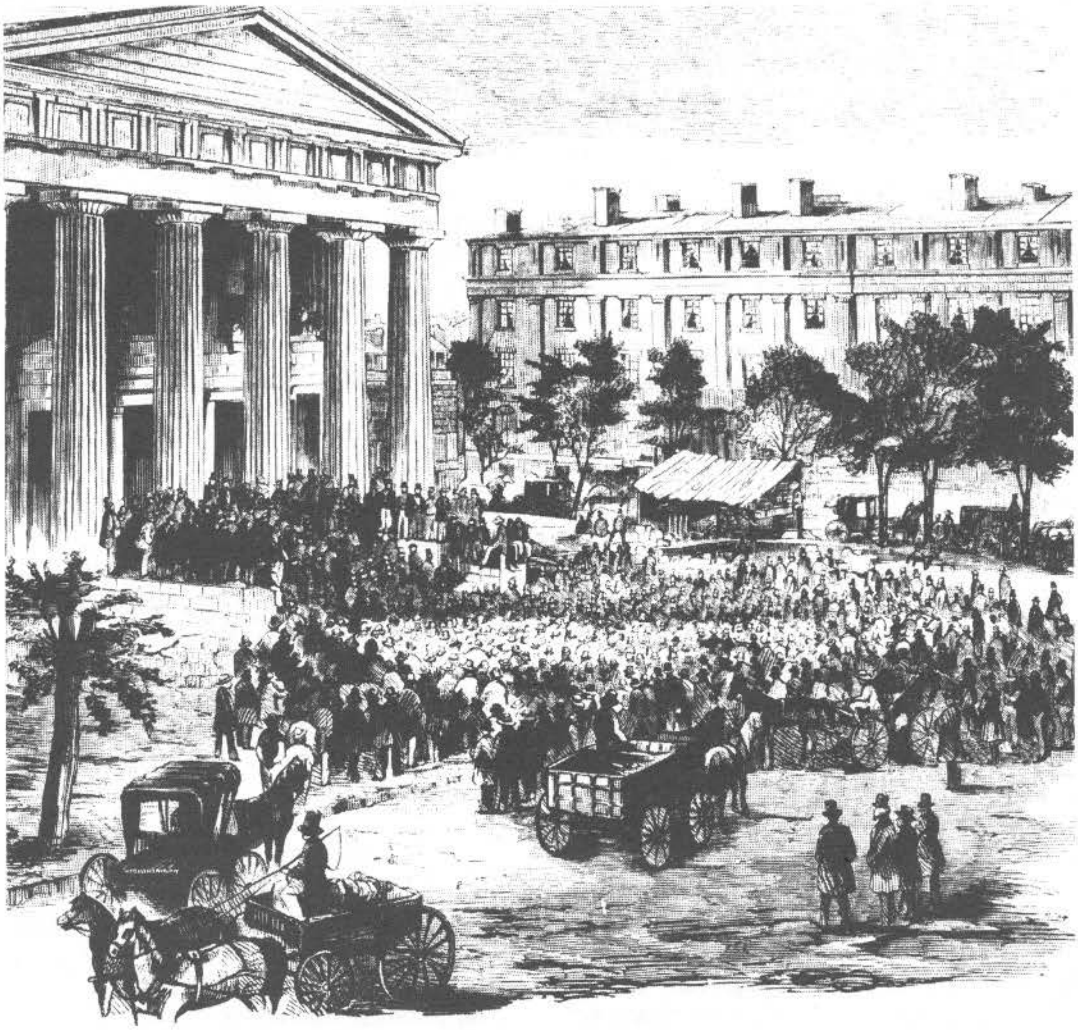


Figure 40. Coursed ashlar walls and fluted columns are prominent in this view of the east portico of the Old Courthouse; construction was about to begin on the north wing. A crowd of 1,500 was gathered to discuss the Kansas slavery issue. Leslie's Illustrated Newspaper, September 13, 1856. Courtesy Jefferson National Expansion Memorial/National Park Service.

about 20 miles south of St. Louis. This is very near the type locality. The Kimmswick is typically massive, white to light gray, coarsely crystalline and abundantly fossiliferous. It is almost always extensively burrowed, and weathers to a distinctive pitted or "honey-combed" surface. The coarsely pitted surface of the columns of the east and west porticoes, seen even through the paint, seems to corroborate that they are Kimmswick.

In 1955, new steps were installed at all four Old Courthouse entrances to replace the original worn and deteriorated limestone steps. The new steps are Cold Springs, Minnesota, granite porphyry (Precambrian). The similar granite porphyry wall supporting the iron fence is also a recent re-creation.

One of the most memorable features of the Old Courthouse interior is the stone floor. In August of 1843, a contract was let for covering the rotunda floor. It called for limestone flagging not less than 3 1/2 inches thick, a center stone 8 feet in diameter and not less than 6 inches thick, and four stone plinths (for columns) about 2 feet 4 inches square and 15 inches deep. The flagging, as described, as well as that in the north and south corridors, was laid in 1844. Except for wear, it is essentially unchanged today.

Most limestone flags are very fine-grained to dense for maximum resistance to wear. Many slabs are sparingly fossiliferous. It appears as if most Courthouse flagging was originally hand dressed to a textured surface, to improve traction. These grooved surfaces are still seen immediately adjacent to walls and in other slack-use areas; the same slabs are worn smooth in main trafficways. Similarly, almost all the Courthouse's old limestone steps were finished with heavily stippled, non-slip surfaces. At least some of the flags and steps in the Courthouse are St. Louis Limestone.

In the Courthouse, as "completed" in 1845, the rotunda's first balcony extended inward several feet farther than it does today, and was supported by four massive, one-piece stone columns. In 1870, the balcony was cut back and the old stone columns removed to Tower Grove Park (in south St. Louis). The four square base stones they stood on (the "plinths for columns" described earlier) can still be seen in the rotunda floor today.

The two oval courtrooms on the second floor of the Courthouse were considered the most handsome in the building (some said "in the West"!) when they were completed in 1856-58. Much of the praise can be attributed to the flooring that was installed. Earlier courtrooms had been floored with brick; these were decked with tiles of the finest available local "marble." (There are no true marbles in Missouri; these are limestones that take and hold a good polish.) The courtrooms were restored in 1955-59 and afford an excellent opportunity to examine two varieties of Missouri "marble" rarely seen today.

A May 1855, contract with the Empire Stone Company, for flooring to be laid in the east courtroom, specifies use of "the fine variegated marble known as McPherson marble." This "marble," an informal member of the Plattin Limestone (Ordovician), was produced from a small quarry in Jefferson County, about 20 miles south of the city. The stone had already gained some local notoriety when a large commercial building on Fourth Street, McPherson's Marble Block, was built of it. Typically it is a light-tan to chocolate-brown, dense- to fine-grained limestone; it may be dolomitic or finely laminated, and commonly has a striking "birdseye" mottling. Most of the flooring seen today is original, but there are some replacement tiles of fine-grained, even-textured, light-gray Carthage "marble" (Mississippian Warsaw limestone) from Jasper County, in southwest Missouri. The floor also includes tiles of imported (Italian?), gray-streaked marble.

In November of 1856 the county arranged to have installed in the west courtroom "tiles of the fine marble obtained near the Iron Mountain in this State ... The tiles are to be 12" x 12" ... one inch thick ... to be alternate ... Light and Flesh Color." The stone contracted for is informally called Taum Sauk "marble" and is a limestone facies of the Bonneterre Old Courthouse/ Masonry and Marble Formation (Cambrian). It has been quarried in very limited amounts from a handful of locations in Iron, Madison, and Reynolds counties in southeast Missouri. Taum Sauk is typically a dense to fine-grained limestone, variegated or mottled, and often traversed by small seams of crystalline calcite. Color and texture vary considerably from one location to the next. Taum Sauk "marble" is most commonly red or pink, but lighter colored varieties, gray or buff, streaked with green and yellow, have been described. The alternating "checkerboard" arrangement of tiles in the west courtroom is striking (fig. 41), and much of the tile appears to be original. The unavailability of this stone forced restorers to replace missing tiles with the best substitute that could be located. Several are replaced with common, Italian(?), gray-streaked (public-restroom wall) marble.

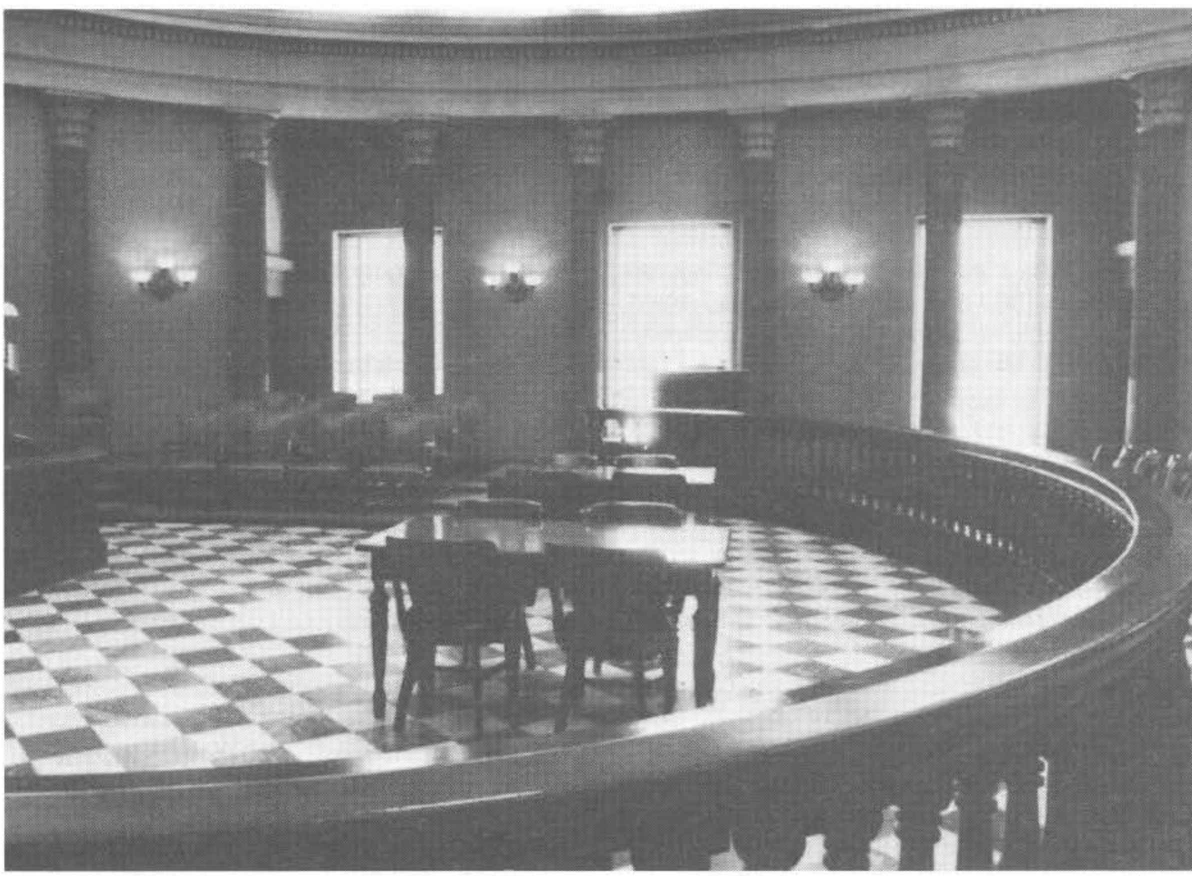


Figure 41. "Checkerboard" arrangement of "marble" tiles on floor of restored west courtroom on second floor of Old Courthouse. The 12 x 12 inch, dark red and tan tiles are Taum Sauk "marble," quarried about 1856 in southeast Missouri. Photo by Joseph Matthews. Courtesy Jefferson National Expansion Memorial/National Park Service.

BIBLIOGRAPHY

Baker, Ira Osborn, 1916, A treatise on roads and pavements, 2nd edition: New York, John Wiley and Sons, Inc., 698 p.

Behrmann, Elmer H., 1984, The story of the Old Cathedral: St. Louis, Nies/Kaiser, 70 p.

Broadhead, G.C., 1884, Missouri, in Report on the building stones of the United States, and statistics of the quarry industry for 1880, in 10th Census of the United States: U.S. Department of the Interior, Census Office, p. 265-274.

Bryan, John A., 1961, Iron in St. Louis architecture between 1800 and 1900: unpublished report, copy on file at Jefferson National Expansion Memorial, St. Louis, 73 p.

Buckley, E.R., 1907, Public roads, their improvement and maintenance: Missouri Bureau of Geology and Mines, v. 5, 2nd series, 124 p.

_______and Buehler, H.A., 1904, The quarrying industry of Missouri: Missouri Bureau of Geology and Mines, v. 2, 2nd series, 371 p.

Cox, James, 1894, Old and new St. Louis: St. Louis, Central Biographical Publishing Company, 575 p.

Cozzens, Arthur B., 1941, The iron industry of Missouri: Missouri Historical Review, v. 35, n. 4, p. 509-538 and v. 36, n. 1, p. 48-60.

Crane, G.W., 1912, The iron ores of Missouri: Missouri Bureau of Geology and Mines, v. 10, 2nd series, 434 p.

Dosch, Donald F., 1979, The Old Courthouse: St. Louis, Jefferson National Expansion Historical Association, 129 p.

Dry, Camille N., and Compton, Richard J., 1875 (reprint 1971), Pictorial St. Louis, the great metropolis of the Mississippi Valley: St. Louis, Harry M. Hagen, 122 p.

Faherty, William Barnaby, S.J., 1981, Dream by the river, two centuries of St. Louis Catholicism, 1766-1980: St. Louis, River City Publishers, Limited, 250 p.

Fenneman, N.M., 1911, Geology and mineral resources of the St. Louis Quadrangle, Missouri-Illinois: U.S. Geological Survey, Bulletin 438, 73 p.

Franzwa, Gregory M., 1980, The Old Cathedral: Gerald, Missouri, The Patrice Press, 144 p.

Gill, McCune, 1938, The old St. Louis riverfront: St. Louis Public Library, 20 p.

Henderson, David G., 1985, Historic structure report, phase II, exterior preservation, Old Courthouse, Jefferson National Expansion Memorial National Historic Site, Missouri: U.S. Department of the Interior, National Park Service, 213 p.

Howe, W.B., and Koenig, J.W., et al., 1961, The stratigraphic succession in Missouri: Missouri Geological Survey and Water Resources, v. 40, 2nd series, 185 p.

Kisvarsanyi, Eva B., Hebrank, Arthur W., and Ryan, Richard F., 1981, Guidebook to the geology and ore deposits of the St. Francois Mountains, Missouri Contribution to Precambrian Geology 9); Missouri Department of Natural Resourses, Division of Geology and Land Survey, Report of Investigations 67, 119 p.

Ladd, G.E., 1890, Notes on the building stones, clays and sands of Iron, St. Francois and Madison Counties, Missouri: Geological Survey of Missouri, Bulletin 1, p. 22-44.

________1890, The clay, stone, lime and sand resources of St. Louis City and County: Geological Survey of Missouri, Bulletin 3,p. 5-84.

Lamar, J.E., and Willman, H.B., 1955, Illinois building stones: Illinois State Geological Survey, Report of Investigations 184, 24 p.

Lindenbusch, John H., 1982, Historic structure report, historic data section --part 1, and historic grounds study, Old Courthouse, Jefferson National Expansion Memorial National Historic Site, St. Louis, Missouri: U.S. Department of the Interior, National Park Service, Denver Service Center, 298 p.

Norris, James D., 1964, Frontier iron, the Maramec Iron Works, 1826-1876: Madison, The State Historical Society of Wisconsin, 206 p.

Olson, Clarence E., 1959, Restoration of the Old Cathedral, in Pictures (Sunday July 19, 1959): St. Louis Post Dispatch.

Patton, John B., 1974, Glossary of building stone and masonry terms: Indiana Department of Natural Resources, Geological Survey, Occasional Paper 6, 15 p.

Polinsky, Gerald R., 1954, The construction of the Illinois and St. Louis Bridge at St. Louis, 1867-1874 (A.M. thesis): St. Louis, Washington University.

Pratt, W.P., Anderson, R.E., Berry, A.W., Jr., Bickford, M.E., Kisvarsanyi, E.B., and Sides, J.R., 1979, Geologic map of exposed Precambrian rocks, Rolla 1° x 2° Quadrangle, Missouri: U.S. Geological Survey, Miscellaneous Investigations Series, I-1161, 1:125,000 scale.

Primm, James Neal, 1 981, Lion of the valley, St. Louis, Missouri: Boulder, Colorado, Pruett Publishing, Company, 592 p.

Reps, John William, 1989, St. Louis illustrated: Columbia, University of Missouri Press, 198 p.

Scharf, J. Thomas, 1883, History of St. Louis City and County, 2 volumes: Philadelphia, Louis H. Everts and Company, 1943 p.

Schulte, Paul C., 1934, The Catholic heritage of St. Louis, A history of the Old Cathedral Parish: St. Louis, The Catholic Herald, 274 p.

Scott, Quinta, and Miller, Howard S., 1979, The Eads Bridge: Columbia, University of Missouri Press, 142 p.

Swallow, George C., 1855, The first and second annual reports of the Geological Survey of Missouri: Missouri Geological Survey, 446 p.

Thompson, Thomas L., 1986, Paleozoic succession in Missouri, Part 4--Mississippia System: Missouri Department of Natural Resources, Division of Geology and Land Survey, Report of Investiyations 70, 189 p.

Toft, Carolyn Hewes, and Overby, Osmund, 1977, Laclede's Landing, a history and architectural guide: Landmarks Association of St. Louis, Inc., 32 p.

Wayman, Norbury, 1969, History--physical growth of the City of St. Louis: St. Louis City Plan Commission, 46 p.

Wheeler, H.A., 1896, Clay deposits: Missouri Geological Survey, v. 11, 1st series, 622 p.

Wild, J.C., 1841 (reprint 1948), The valley of the Mississippi illustrated in a series of views, edited by Lewis Foulk Thomas: St. Louis, Hawthorn Publishing Company, no pagination.

Woodward, Calvin M., 1881, History of the St. Louis Bridge: St. Louis, G.I. Jones and Company, 411 p.

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S.P. 6 **THE GEOLOGIC STORY OF THE ST. LOUIS RIVERFRONT (A Walking Tour)**

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