THE MINE LA MOTTE LEAD DEPOSIT, MADISON COUNTY, MISSOURI

by

JOHN EDWARD McCORMIC

1993

OPEN FILE REPORT SERIES

OFR-93-94-GS

Missouri
Department of
Natural Resources

Geological Survey and Resource Assessment Division
P.O. Box 250, Rolla, MO 65402-0250
PHONE (573) 368-2125 FAX (573) 368-2481
E-MAIL gsradpubs@dnr.state.mo.us

Integrity and excellence in all we do

THE MINE LA MOTTE LEAD DEPOSIT
Madison County, Missouri

by
John Edward McCormick

1993

OFR 93-94-GS

MISSOURI DEPARTMENT OF NATURAL RESOURCES
Division of Geology and Land Survey
P.O. Box 250, Rolla, MO 65401
(314)368-2125

TABLE OF CONTENTS

FIGURES

Aerial photo of Mine La Motte #18 Mine & Mill. Photo courtesy of St. Joseph Lead Company.

The Mine La Motte Lead Deposit
Madison County, Missouri

John Edward McCormick

INTRODUCTION

Commencing in 1723, lead was produced intermittently in the Mine La Motte area for 235 years. The original land grant, known as the Domain, contains almost 25,000 acres. It is in the northeast corner of Madison County, Missouri and about 5 miles north of Fredericktown (fig. 1). The south end of the old Lead Belt, in St. Francois County, is approximately 20 miles north of Mine La Motte.

The original workings, which are in the western part of the Domain, and the more modern surface and underground mines to the east, have all been mined in the original land grant. The recent operations include the 14 and 18 Mines and the redevelopment of the older Jack Diggings and Offset areas into open cuts (fig. 2). The Sheldon property, on which 26 Mine is located, is a recent addition to the area and is not in the Domain. St. Joseph Lead Company purchased the property in the early 1950s, as a separate and independent unit, after finding a commercial lead and zinc orebody. Economic factors closed the mines in July, 1958.

Figure 1. Map showing location of Mine La Motte

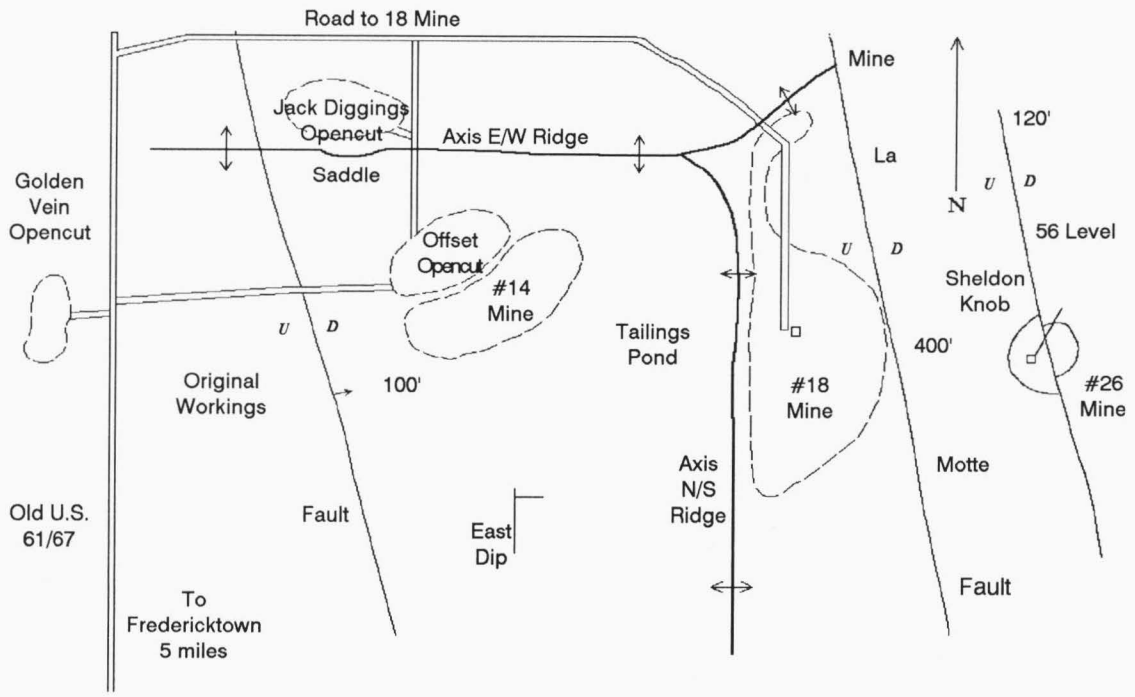

Figure 2. Geographical and structural map (no scale)

HISTORY

The history of Mine La Motte covers a period greater than that of any other mining operation west of the Mississippi River. There is historical evidence that the great explorer, Hernando De Soto, came into southeast Missouri in 1541 and that two of his men, accompanied by Indian guides, visited the lead deposits of Madison County in their quest for gold.

As a result of Spanish conquests in the new world in the early 1700s, Louis XIV of France was prompted in 1712 to make a grant of the entire Louisiana territory to Anthony Cruzat. He was to develop the vast gold and silver deposits that were believed to exist in the territory. On one of his expeditions, he discovered and developed the prospect, which is now called Mine La Motte. It was named after the first governor of the territory, Antoine de la Mothe Cadillac.

Cruzat returned his patent to the king in 1717, after failing to find gold. During the same year, John Law received a grant to the territory and organized the Company of the West. As a member of the company, Philip Francois Renault sailed to New Orleans in 1720. He travelled up the Mississippi River and from there found the pits of de la Mothe Cadillac. The Company of the West failed, so the king granted Renault a piece of land at Mine La Motte. The first lead was mined and shipped to France in 1723, but two years later Renault returned the property to the crown.

Spain gained possession of Louisiana in 1745 and granted Francois Valle 1,666 acres of land at Mine La Motte. As a result of frequent Indian attacks and the loss of Valle's son, Spain granted Valle an additional 23,333 acres. This total acreage constitutes the Domain as it now exists. Some

lead used during the Revolutionary War was mined from Valle's operation.

Spain returned the territory of Louisiana to France in 1802, and in 1803 the United States purchased the territory. The Valle heirs appealed to the United States government to confirm their claim to the Domain and it was granted in 1827, but the following year the court ordered the tract to be sold. It was purchased by a group of men, including some of Valle's heirs, who formed the Mine La Motte Mining Company.

The Company operated on a contract or lease system. A contractor leased a plot of ground about 50 feet square and did all exploration, shaft sinking, mining, etc., and sold the ore to the company. The system was quite wasteful and more shafts than necessary were sunk. This system of early mining accounts for the numerous pits and shallow shafts found west of the Offset and in the Jack Diggings areas. Many of these operations were destroyed during the Civil War.

The Mine La Motte Lead and Smelting Company, formed in 1868, was operated by Rowland Hazzard. He used the same contract or lease system. During World War I, the area was worked by the Missouri Metals Corporation. In 1918, the Sweetwater Mining Company acquired the Domain and shipped its ore to the St. Louis Smelting and Refining Company, the parent to the National Lead Company. The St. Joseph Lead Company leased the Domain in 1922 to prospect for additional lead. Prospect drilling was successful and in 1928 the Domain was purchased jointly by St. Joe and the National Lead Company. St. Joe became the operator of the newly formed Mine La Motte Corporation.

GEOLOGY

Mine La Motte is on the eastern edge of the St. Francois Mountains, which are composed of granite and volcanic rocks. Paleozoic sediments dip gently eastward, except for local variations near Precambrian highs. The basal section of the Upper Cambrian Bonneterre Formation and the upper few feet of the Lamotte Sandstone are the host rocks for the lead deposits. The orebodies are genetically related to Lamotte Sandstone pinchout zones adjacent to buried Precambrian knobs and ridges.

Stratigraphy

Lamotte Sandstone

The Lamotte Sandstone (fig. 3) unconformably overlies a Precambrian granite and rhyolite porphyry basement. The Lamotte is a poorly cemented, fine- to medium-grained, well-rounded white quartz sand. Near the 26 Mine the Lamotte grades from white to gray sand and locally contains green shale banding.

Green Sand Facies

The green sands, a facies of the upper Lamotte Sandstone, are locally derived quartz sands that are formed from the weathering of Precambrian granite knobs and ridges in the region; they are closely associated with structural highs and the surrounding current direction. The green sands were deposited next to knobs and ridges from late Lamotte time well into the deposition of the Bonneterre transition zone. Much of the material was formed during the long Precambrian erosional period and was incorporated in the basal sediments (Richard E. Wagner, personal communication, 1954). By the end of Bonneterre transition time, the small amount of remaining

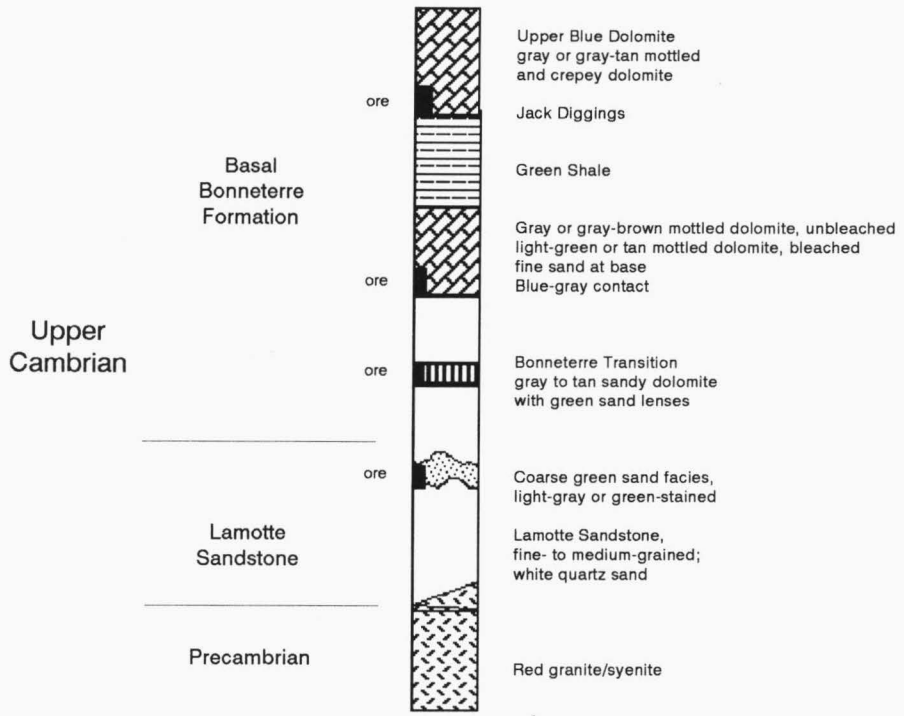

Figure 3. Stratigraphic column, Mine La Motte

land surface, combined with continued sea deepening, prevented the formation of additional green sand beds.

The green sand, a coarse, poorly sorted quartz sand, is light gray or green stained. Insoluble residue studies of the sand in the mine areas indicate that 85 percent is quartz and the remaining 15 percent mostly iron sulfide with a pale greenish clay identified as illite (John S. Brown, personal communication, 1954).

The top of the green sand is 30 to 50 feet below the blue-gray contact. The green sand varies from a few feet to ten feet thick in the mine workings. Normal Lamotte Sandstone underlies the green sand unit.

Bonneterre Formation

The Bonneterre Formation (fig. 3), conformably overlying the Lamotte Sandstone, is 500 feet thick in the Mine La Motte Region. Only the lower 60 to 70 feet of the Bonneterre is mineralized in the underground workings; the zones include the Bonneterre sandy transition, which averages 40 feet thick, and the overlying sandy blue-gray dolomite which is 20 feet thick at 18 Mine. A 30-foot green-shale section, above the blue-gray bed, is an impervious barrier to further vertical mineralization.

The lower 10 to 15 feet of the upper blue zone, equivalent to the Bonneterre 12 zone in the old Lead Belt, is mineralized, but only in the open cut at the Jack Diggings. The upper blue bed overlies the green shale unit.

Bonneterre Sandy Transition

A transition zone, from the top of the Lamotte Sandstone upward to the blue-gray contact, consists of numerous gray to tan sandy dolomites, dolomitic sands, and sandstones. The fine- to medium-grained sand grains are typically Lamotte. The transition zone is 30 to 50 feet thick where the

green sand is present and up to 60 feet thick where it is absent.

Green sand beds or lenses can occur anywhere in the transition, but are normally about 20 to 25 feet above the top of the green sand facies. The lenses are believed to be channels that were filled with coarse green sand; they pinch out into thin green shale bands that parallel normal bedding. The green sand lenses are generally narrow, from 50 to 100 feet wide. Their strike length is 200 to 400 feet and are up to 3 feet thick. The lenses exhibit compaction, as shown by a pronounced vertical fracture pattern paralleling their edges.

Sandy Blue-Gray Dolomite

The sandy blue-gray bed is basically a gray or gray-brown mottled dolomite when unbleached. The mottled character is due to a snurly dissemination of dark shale mixed thoroughly through the rock. The bed also contains a large amount of very fine, almost silt-sized, scattered sand, which is not of the Lamotte type. The sandy blue-gray dolomite, usually 20 feet thick in the mine workings, is somewhat thicker at 26 Mine. Solutions penetrating the dolomite from the blue-gray contact upward to about 10 feet bleached the usual gray-brown rock to a light, slightly greenish tan. The mineralizing solutions were possibly the bleaching agent.

Several features of this bed suggest that it may be of organic origin. It appears to be essentially an algal-bedded reef that grew on top of the Bonneterre transition zone, but was smothered out by deposition of the overlying green shale unit.

Upper Blue Dolomite/Green Shale

The upper blue dolomite is a thin-bedded, fine-grained, gray or gray-tan dolomite with a crepey and mottled texture. The underlying green shale unit is characterized by much green shale, approximately 30 feet thick and containing 40 to 50 percent shale.

STRUCTURE

The Mine La Motte area has two dominant buried Precambrian granite ridges (fig. 2). The first is an east-west-trending ridge, approximately two miles long. The Offset, 14 Mine, and the north end of 18 Mine are along its south flank. The second ridge trends north-south and is about a mile long. The 18 Mine parallels its east flank. The 26 Mine, just east of the Mine La Motte fault, is associated with a buried Precambrian knob. The mine has not been fully developed, but most of the ore is on the east and south flanks of the syenite knob.

Several major northwest-striking, high-angle, normal faults, downfaulted 100 to 400 feet on their northeast sides, are part of the Simms Mountains fault zone that extends southeastward from a point west of the old Lead Belt. One fault, just west of the Offset area, is downfaulted 100 feet. The major Mine La Motte fault, in the eastern part of the Domain, between 18 Mine and the new 26 Mine, is downfaulted 400 feet. A northwest-trending step fault, downfaulted 120 feet, cuts the orebody at 26 Mine. Several other faults in the area have only minor displacements.

ORE OCCURRENCE

Three major ore horizons occur in either the lower Bonneterre Formation or the upper Lamotte Sandstone at Mine La Motte. The lower ore horizon is the green sand facies between the

Lamotte-Bonneterre transition zone. The middle ore horizon is in the transition zone, in green sand lenses. The upper ore horizon is in the bleached sandy dolomite bed directly above the blue-gray dolomite.

Green Sand Facies

The green sand is an important mineralized zone. The best ore is at the Bonneterre transition and green sand contacts. As sediments were deposited, their weight caused the semi-fluid green sands to shift and compact. Because of the still plastic state of the Bonneterre transition, the underlying green sands were forced upward into the lower transition zone forming either humps or mushroom-shaped diapiric structures that extend as much as 10 feet (fig. 4A) into transition zone rocks. Location of these structures is controlled by irregularities in the underlying Lamotte Sandstone, which can be described as small sand bars built by wave action around Precambrian highs.

As the structures weather in mined-out areas, oxidized iron heavily stains the sand, and causes the structures to stand out dramatically. Heavy green shale derived from the illite clay outlines the structures. Strong fractures, some filled with green sand, radiate upward from the structures. Light mosaic breccia may be present at the top of the structures with the breccia matrix being calcite and occasionally a black bituminous material. Galena is in these structures and is concentrated near their apex as open-space filling.

Green-sand structures have been mined at 18 Mine, 14 Mine, the Offset, and the Golden Vein. The strongest development of mineralized green sand at 26 Mine is on the east flank of the Precambrian knob. It is quite likely that the original shallow mining in the western part of the Domain was in the green sand facies. This horizon generally contains the higher grade of lead. Chalcopyrite and siegenite are found only in the green sand unit.

Bonneterre Sandy Transition

Mineralization is also prominent in the middle Bonneterre transition zone, in green sand lenses (fig. 4B): galena is disseminated throughout them. The ore is open-space filling in the porous coarse green sand. Several such lenses can be either stacked or offset from one another in the same stope.

The mineralized green sand lenses, mined at 18 Mine, 14 Mine, and the Offset area, have not been observed at 26 Mine, where they are believed to be less developed.

Sandy Blue-Gray Dolomite

The sandy blue-gray bed is the uppermost zone containing favorable mineralization in the mine workings. Most commonly a bleached zone extends upward to about 10 feet into the blue-gray bed; the best Galena is at the bleached-unbleached contact and disseminated downward into the bleached rock (fig. 4C). Galena, a replacement ore, can also be at the unbleached base of the blue-gray bed along the blue-gray contact. Some mineralization can extend several feet down into the sandy transition zone.

Ore in the blue-gray bed has been mined at 18 Mine and possibly deep in 14 Mine. This unit was closed during the time of the writer's residence. The blue-gray bed is not in the Offset area. The largest ore tonnage at 26 Mine is in this horizon; most of it is on the east side of the Precambrian knob.

Upper Blue Dolomite

The open cut at the Jack Diggings, the only place at Mine La Motte where ore is above the green shale, is on the north flank of the east/west-trending buried Precambrian granite ridge. A saddle in the granite ridge allowed ore solutions to pass through and mineralize the basal upper

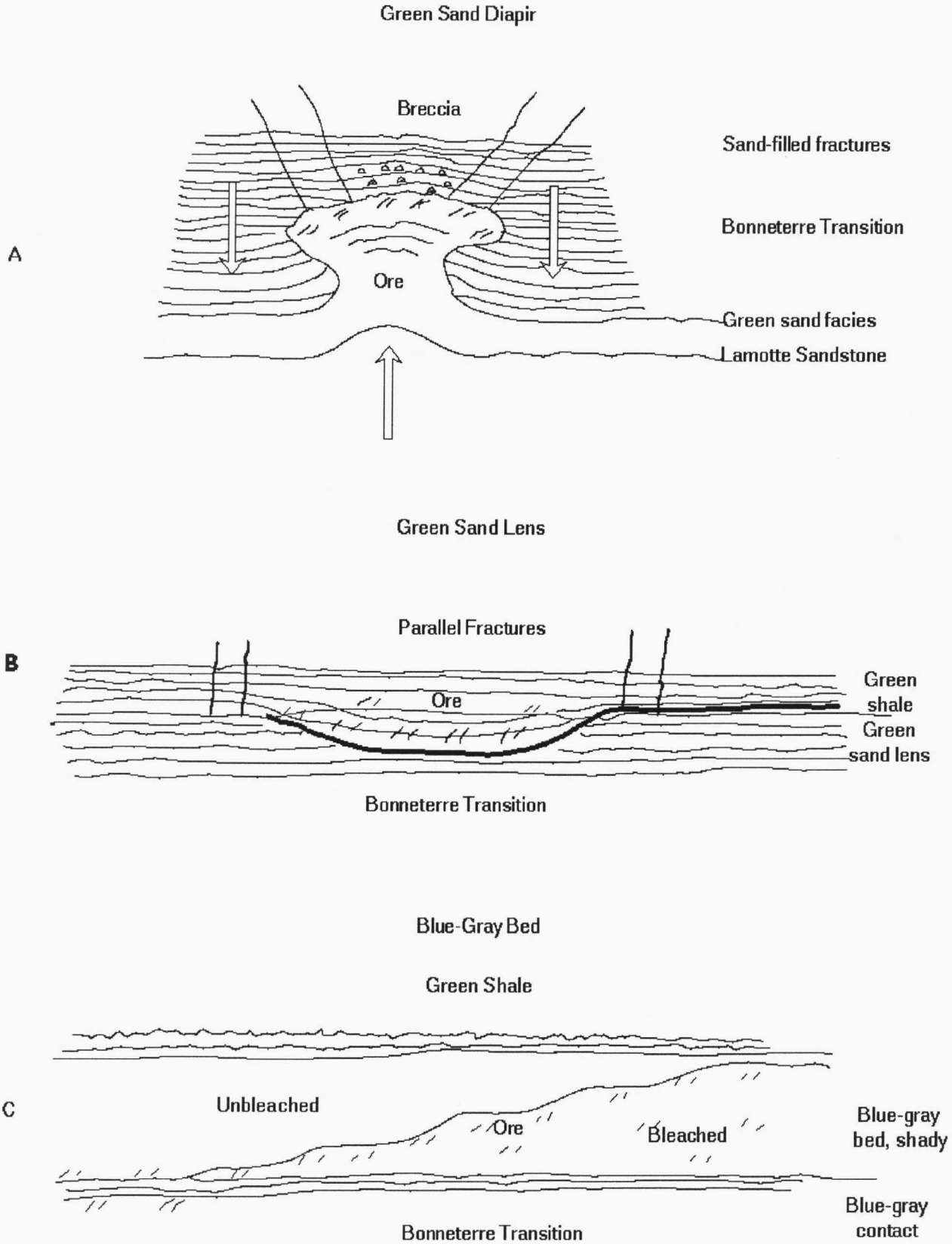

Figure 4. Generalized ore structures

blue dolomite. Galena is either disseminated in the dolomite or present along bedding planes. A 30-foot green-shale section is in the open-cut floor. The upper section of the blue dolomite has been eroded.

Mineralogy

Ore deposit mineralogy at Mine La Motte is relatively simple. Galena is the dominant lead mineral. Lead carbonate ores were mined in near-surface workings many years ago. Other minerals associated with the orebodies include sphalerite, chalcopyrite, and siegenite, a nickel-cobalt mineral. A few traces of millerite, a nickel sulfide, have been core logged. Gangue minerals include marcasite, pyrite, calcite, and quartz as sand grains. Large scalenohedral calcite crystals have been found in several large vugs at 18 Mine. A black bituminous material has been noted in some green sand structures.

Almost all mineralization is on the south or east flanks of buried Precambrian highs. It is generally accepted that mineralizing solutions moved laterally through the upper Lamotte Sandstone to pinchout zones adjacent to Precambrian highs and then migrated upward into the lower Bonneterre Formation. It is logical to surmize that ore fluids moved into the area from the southeast. The presence of hydrocarbons in the area leads one to speculate that the mineralizing solutions may have originated from migrating basinal brines from the east.

MINING AND EXPLORATION

In the early years of Mine La Motte, mining was done by digging open pits and sinking shallow shafts. This work was entirely in the western part of the Domain. The basal Bonneterre transition zone and green sand facies were near or at the surface; thus the ore was readily available. Due to erosion and weathering, much of the lead and lead carbonate was concentrated at the contact between cap rock and overburden. This possibly accounts for the better-than-average grade, not only of lead, but also of copper and nickel-cobalt.

During later years, as mining extended down dip and went underground, room-and-pillar extraction was adopted. Column-mounted drills and jacklegs broke the ore, St. Joe electric shovels loaded it into rail cars, and electric locomotives transported the broken ore to the shaft. At the Offset and Jack Diggings, a diesel shovel loaded the ore and trucks hauled it to the mill.

The Atlas jackleg and Swedish sectional steel, new underground prospecting tools, were introduced to Mine La Motte in 1954. The steel sections were 4 feet long and joined together by 6-inch couplings. Rock cuttings were taken at 4-foot intervals; the samples were panned and then assayed for lead. Sectional steel permitted deeper rock penetration, and immediately outmoded the old prospecting method, which was limited to 10-foot holes. Thirty- and forty-foot holes were drilled into backs and floors of favorable stopes and new ore was discovered in the major ore horizons.

The new prospecting method was used at the Offset to test the old open-pit periphery. Ore was discovered in the immediate back of old stopes and upward to the overburden; similar results occurred at the Jack Diggings. Both areas were stripped of fairly thin overburden and open cuts were developed.

In the early 1950s, St. Joe did extensive surface diamond drilling on the optioned Sheldon property adjacent to the eastern boundary of the Domain. The property was also on the down-faulted side of the major Mine La Motte fault. One thousand-foot holes were required to intersect the three main ore zones. The excessively thick overburden, 200 to 300 feet thick, is heavily

disseminated with chert and quartz druse from the weathered Potosi Dolomite. Churn drills penetrated the overburden and sleeves were set to the top of the cap rock, usually the Derby-Doe Run Dolomite. A diamond drill completed the hole by penetrating the Davis and upper Bonneterre Formations and finally coring the lower Bonneterre to the top of the Lamotte Sandstone.

Commercial ore was discovered associated with a buried Precambrian knob. The 26 Shaft was started in 1956, near the center of the knob. Three levels were planned for 26 Mine. The upper level was directed at the ore on the upside of the fault cutting the orebody. This structure is downfaulted 120 feet on its northeast side. The second and lower levels drifted to the ore on the downfaulted side. The bottom level has an elevation of 56 feet above sea level. The mine is designed for trackless haulage, a feature similar to present day mining methods.

PRODUCTION AND RESERVES

Production figures for lead have hitherto been compiled from estimates, railway freight bills, U.S. government reports, sales book records, and current mill reports.

YEAR	TONS PB	GRADE
1723/1876	55,300	n/a
1877/1924	118,000	n/a
1925/1958	229,700	2.7%
1723/1958	403,000	3.5% (est.)

The Mine La Motte area, including 26 Mine, should have an estimated ore reserve balance exceeding 2,000,000 tons of ore at a grade of 2.50 percent lead. The average orebody is 10 feet thick. A small tonnage of zinc ore is at the 26 Mine. The flooded Offset floor contains approximately 1500 tons of nickel-cobalt ore with an estimated grade of 1.5%. The ore is in the green sand facies.

ACKNOWLEDGMENTS

The writer gratefully acknowledges the assistance of Delbert Harper, manager of Asarco's Eastern Exploration Department; Vance Greene, Chief Geologist of Asarco's Tennessee Mines Division; and Robert Fulweiler, Chief Geologist for the Tennessee Division of Geology - Knoxville for offering constructive comments and suggestions toward preparing this paper, and the Department of Natural Resources' Division of Geology and Land Survey for publication and distribution of this report.

BIOGRAPHICAL SKETCH

John Edward McCormick received his Bachelor of Arts degree in Geology in 1950 from Muhlenberg College, Allentown, Pennsylvania. He also did graduate work in geophysics at Washington University, St. Louis, Missouri during the mid-1950s.

McCormick was employed by the St. Joseph Lead Company in December 1950, and worked as a resident mine geologist at Mine La Motte in Madison County, Missouri from July 1953 to October 1957. He did extensive mine mapping at Mines 18 and 26, the Offset, the Jack Diggings, and was in charge of all surface diamond drilling on the original land grant of that area.

In October 1962, he left St. Joseph Lead Company and joined American Zinc Company in Mascot, Tennessee as Senior Geologist in 1966. In addition to his work in Missouri and Tennessee, he worked in the Balmat-Edwards zinc district in upper New York, Metalline Falls lead-zinc district in northeast Washington, and the Fluorspar district of southern Illinois.

In 1971, Asarco Incorporated acquired the assets of American Zinc in East Tennessee. In 1975, McCormick was made Chief Geologist for Asarco's Tennessee Mines Division. He retired in December of 1985 after 35 years in the field of economic geology.

Other publications by John McCormick include *Environment of the Zinc Deposits of the Mascot-Jefferson City District, Tennessee,* Economic Geology in August 1971, and several smaller state reports on the Geology of Young and New Market mines of East Tennessee.