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## ABSTRACT

There are three iron ore districts in the central United States. In the Russellville, Alabama district the ores are residual limonite, and in the East Texas district the limonite ores are of Tertiary age. Residual limonite-hematite deposits and Precambrian hydrothermal deposits occur in southeastern Missouri.

Since production began in 1815, Missouri has produced a total of approximately 14 million tons of ore, of which about two-thirds has been from Precambrian deposits.

The sedimentary deposits are of two types: (1) residual limonite fragments concentrated in a cherty clay residuum overlying Paleozoic carbonates, and (2) hematite occurring within solution depressions, commonly called "filled-sink" deposits.

The ore minerals of the Precambrian deposits that occur as fissure fillings and replacement veins are hematite, magnetite, and martite. Spatial relations of the minerals suggest a zonal arrangement both regionally and in individual deposits. Important gangue minerals are quartz, apatite, fluorite, garnet, and amphiboles.

The sedimentary deposits were explored in the past by test pits or trenches. Recently, many deposits have been prospected by test drilling with churn drills. Electrical resistivity surveys are of value for determining depth to bedrock and are indicative of limonite concentrations.

Precambrian deposits have been explored by dip needle surveys, ground magnetic and gravity surveys, and airborne magnetic surveys. Two major problems are encountered by magnetic exploration of the Precambrian ores: (1) the relief of the Precambrian surface, and (2) variation of the magnetite-hematite ratio in the deposits.

## INTRODUCTION

Although the central United States is not recognized as a major iron ore producing region, it does contain three iron ore districts of considerable importance. These are the Russellville district in northwest Alabama, the East Texas district, and the southeast Missouri district.

The deposits of the Russellville district as described by Burchard (1907) are concentrations of secondary limonite in a matrix of residual clay lying on Mississippian limestone. Eckel (1938) described the East Texas deposits as concentrations of secondary limonite occurring as nodules and honeycombed masses in the Weches greensand member of the Eocene, Mt. Selma formation. Ore occurs where the Weches crops out or is covered by a thin veneer of the overlying Sparta formation.

Iron ore deposits of Missouri may be grouped into two main types: (1) sedimentary limonite and hematite deposits associated with Paleozoic sediments, and (2) hydrothermal deposits of magnetite-hematite ores in Precambrian igneous rocks.

The sedimentary deposits may be further divided into two groups: (1) brown iron (limonite) and (2) filled-sink deposits. The brown ores have recently been described by Hayes (1957) as concentrations of limonite fragments occurring in residual clays derived from Paleozoic carbonates.

The mode of occurrence of these deposits is very similar to the deposits of the Russellville district. Many deposits show evidence that the hydrous iron oxides were formed by alteration of pyrite and marcasite.

Many sink structures in the north-central part of the Ozarks are partly filled with hematite and associated limonite, pyrite, and marcasite. Soft red hematite and hard blue specular varieties form most of the ore. Characteristically, the sinks are surrounded at the surface by a circular or elliptical outcrop of sandstone referred to as rimrock.

Hydrothermal Precambrian iron ore deposits occur in, and are associated with, tuffs and brecciated felsites. The principal ore minerals are magnetite and hematite and occur as replacement veins and fissure fillings in the igneous rocks. The deposits have been described by several investigators, some of whom are Crane (1912), Tolman and Meyer (1939), Singewald and Milton (1929), and Ridge (1957).

## HISTORY AND PRODUCTION

The erection in 1797 of the historic Cumberland furnace in Dickson County, Tennessee, was of great significance to the iron industry of the central United States. The Ashebran furnace erected in 1815 near Ironton, Iron County, was equally significant in being the first furnace west of the Mississippi. This furnace treated Precambrian ores.

Hematite ores from filled-sink deposits were first smelted at the Harrison-Reeves furnace, Franklin County, in 1819 or 1820. Limonitic ores, typical of the deposits in the south-central part of the state, were first smelted at the Springfield furnace, Washington County, in 1823.

Mining of the Precambrian ores at Iron Mountain, St. Francois County, began in 1844, and smelting of the ores on the site began two years later. The first hot blast furnace west of the Mississippi was put in blast at Iron Mountain about 1854. Production from Precambrian deposits has been continuous since 1870 except for the years 1907, 1933, and 1939-41.

Total iron production from Missouri to date is about 14 million tons. Two-thirds of this has been from Precambrian deposits. Development of the North Ranges in the early 1900's caused an appreciable decline of Missouri production for a number of years. Substantial production, in the order of several hundred thousand tons per year, has been maintained since 1945 from Iron Mountain. There has been no production of consequence from the filled-sink deposits since 1945. As the result of recent interest and demand for the low phosphorous brown ores, annual production of these ores has increased since 1947 (when no ore was produced) to 281,427 tons of concentrate in 1957. The ore is shipped to blast furnaces in Illinois, Tennessee, and Alabama.

## ACKNOWLEDGEMENTS

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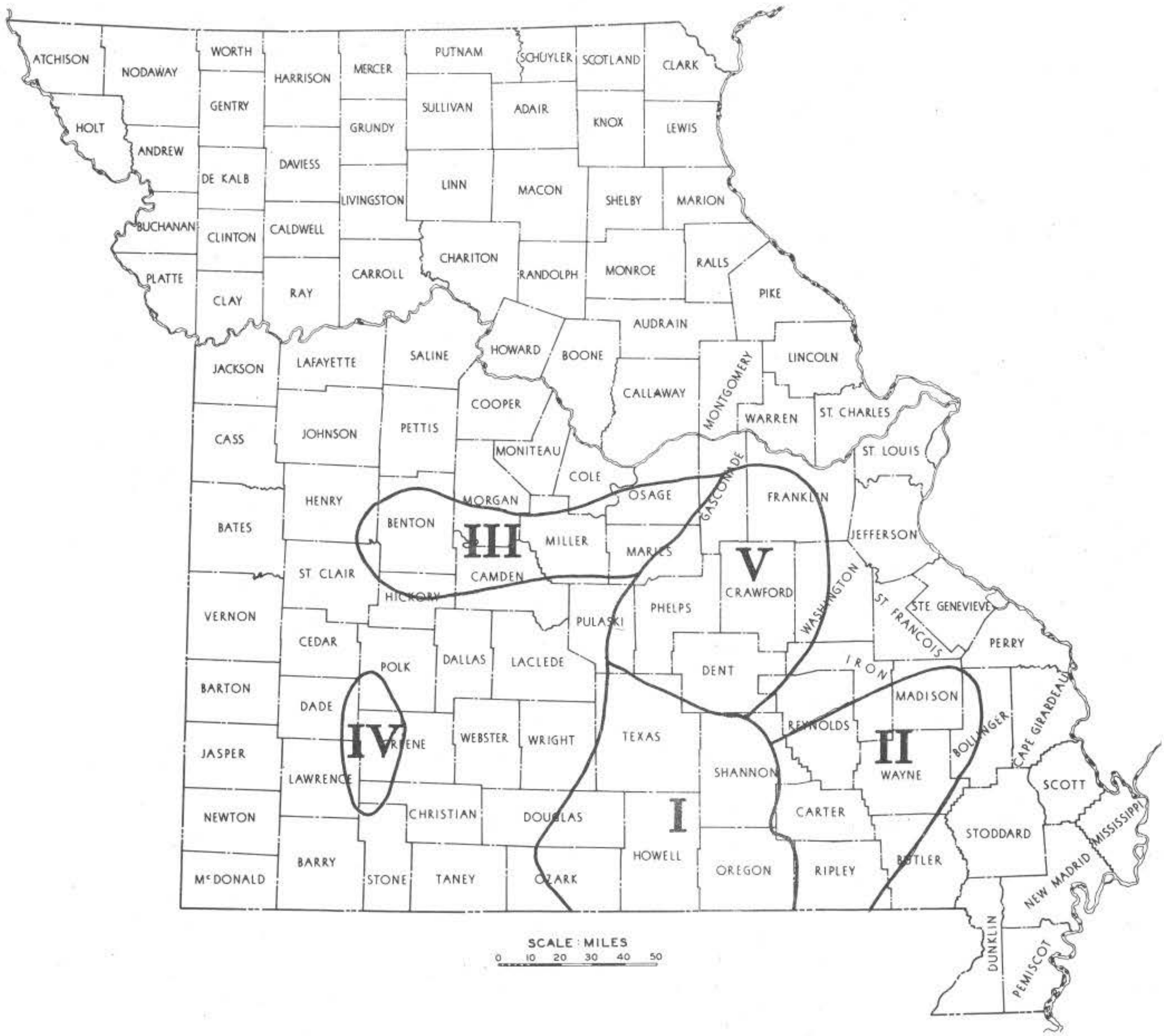
## GEOLOGY OF THE DEPOSITS

### Brown Iron Deposits

Most of the production of brown ore has been from the West Plains and Poplar Bluff districts in the south-central part of the state (Fig. 1). Although most of the ore mineral is goethite, or goethite with varying amounts of adsorbed and capillary water, the term limonite is retained as a convenient field term for all the hydrous iron oxides. Small amounts of hematite are found disseminated in limonite fragments in several deposits.

The brown iron deposits were grouped by Crane (1912, p. 54) as either primary or secondary in regard to origin. However, it has been established that identification of samples as one or the other is extremely difficult and even impossible in most cases. Primary deposits are believed to have been formed by direct deposition of limonite at surface temperatures and secondary deposits by alteration at surface temperatures of pyrite and marcasite to limonite.

Primary ores are typically cellular, soft, and earthy and are usually very cherty or sandy. Some light brown dense ore is observed in places. According to Crane (1912, p. 70), the primary ores typically contain as much as 3.0 percent manganese, which is considerably higher than the manganese content of the secondary ores. Generally, the primary deposits appear to have a greater horizontal extent than the secondary deposits. The size and shape of the deposits are irregular, and there is little apparent geologic control. Crane (1912, p. 67) states that the limonite, at least in part, replaces the residuum in which it occurs, and deposits may intersect the roughly stratified residual material.




# SEDIMENTARY IRON ORE DISTRICTS OF MISSOURI

I WEST PLAINS DISTRICT
II POPLAR BLUFF DISTRICT
III OSAGE RIVER DISTRICT
IV SPRINGFIELD DISTRICT
V STEELVILLE DISTRICT

FIGURE I

Many deposits that have been described as primary by Crane have been visited by the writer, and evidence is now available that a considerable number should be considered as secondary.

Secondary deposits were formed by the concentration of limonite fragments in a cherty clay residuum derived by weathering from Cambrian, Ordovician, and probably Mississippian carbonates. Concentrations of limonite fragments at the surface have led to the discovery of all known secondary deposits. Since 1955, many such surface indications have been explored by drilling, and it has been established that the concentrations of limonite occur in and above depressions in the bedrock. These depressions are interpreted as relict sink holes, or areas of anastomotic solution openings.

The sizes of the deposits range from a few feet in diameter to several acres in extent and from a few feet to over 200 feet in depth. In the West Plains district, the maximum known thickness of the residuum is 252 feet.

Fragments of limonite occur as boulder ore, tabular ore, pipe ore, and ocher. Boulder ore, sometimes called dornick ore, may be cellular or porous. It may also occur as dense masses of irregular shape or as masses of limonite pseudomorphs after pyrite or marcasite. Small veins of limonite that have disintegrated into platy fragments constitute tabular ore. Pipe ore is formed by the alteration of stalactitic masses of marcasite to limonite. All gradations of alteration, from marcasite pipes to limonite pipes, may be observed.

The brown iron deposits of the Springfield district occur near the Mississippian-Pennsylvanian unconformity. Pseudomorphic limonite and a needlelike fibrous variety of goethite are common in many deposits of the district. Known deposits are small and only limited mining operations have been attempted.

A considerable number of small limonite deposits are scattered throughout the Osage River drainage area in the north part of the Ozarks.

## Filled-sink Deposits

Crane (1912, pp. 84-106) describes the hematitic ores of the filled-sink deposits which are concentrated in an area on the northwest flank of the Ozark dome that is referred to as the Steelville district. These ores occur in sink holes within the Gasconade and Roubidoux formations of Early Ordovician age. Surrounding many deposits, a rimrock of the Roubidoux sandstone is present showing centripetal dip. Ore masses of specular hematite are distributed irregularly within a deposit around claylike horses and blocks of bedrock. Soft red hematite is the important ore in many deposits. Marcasite may be found in many deposits, and pseudomorphs after marcasite are present in all filled-sink deposits. Most of the soft red hematite is thought to have been formed by alteration, but Grawe (1945, p. 191) states that part of the specular hematite appears to be a recrystallization product of the red ore.

Near the turn of the century, there was substantial production from the filled sinks, but since 1945 only a few tons have been produced.

## Precambrian Deposits

Hydrothermal deposits of magnetite and hematite are confined to the Precambrian rocks of the state. The Precambrian crops out at the apex of the Ozark dome and forms the St. Francois Mountains in Iron, St. Francois, Madison, and adjoining counties.

Several mining methods have been employed for extraction of the ores from the St. Francois Mountains. Surface operations were the first used for mining residual hematite boulders that had accumulated on and near the surface by erosion of exposed veins. Hematite boulders are also a constituent of the basal conglomerate of the oldest sediment in the area, the Lamotte formation of Late Cambrian age, where it rests upon the eroded Precambrian knobs and hills. The primary veins and replacement ore bodies were initially mined by open pit methods and later by underground stoping.

The ores occur as fissure fillings and irregular replacement veins in the felsites and as replacements and fillings in the tuffs and agglomerates. Hypotheses of Spurr, Geijer, and Ridge favor the introduction of the ore as a melt by magmatic emplacement. Crane, Singewald and Milton, and the writer believe the deposits to be of hydrothermal origin.

Most descriptions refer to both replacement and fissure filling, differing mainly in the relative importance of one or the other. Replacement of the dense aphanitic wall rock has been extensive in many areas, and it is the writer's belief that replacement is more important than fissure filling. At Iron Mountain, replacement has been so extensive that the wall rock is altered for a distance of several feet from its contact with the ore. Small replacement veins so permeate the rock that it appears to be a breccia cemented with ore and gangue. The individual fragments of remaining wall rock are separated and not in contact with one another. At Shepherd Mountain, about six miles south of Iron Mountain, the wall rock is altered for a distance of several inches on both sides of veinlets one-fourth of an inch wide.

Banding and comb structures are common in several deposits but are not as abundant as replacement structures. At Iron Mountain, some vugs are lined with well-developed crystals of hematite, quartz, and calcite.

Several individual deposits at Iron Mountain have been worked in the past. The ore body of the Big Cut has been described as an inverted "U" with a felsite horse in the center. The limbs gradually pinch out with depth. Approximately 2,000 feet southwest of this deposit is the now abandoned Hayes Cut. Vein ore was encountered in the felsite below the conglomerate ore. The vein is reported to have been as much as 50 feet thick with a dip of approximately 40 degrees to the southwest and to have extended for some 400 feet along the strike.

The Main Orebody currently being mined is separated from, but immediately south of and at a lower elevation than, the vein in Hayes Cut. The shape of the Main Orebody has been described as an inverted, three-sided cup. Drilling has shown that the southeast side, or lip, appears to reverse its dip to the northwest. The Northwest Orebody, some 1,000 feet northwest of the Main Orebody, is a steeply inclined vein some 200 feet wide with a 700-foot length along a northwest strike.

Mineralogical studies of many deposits in the exposed Precambrian area indicate that the important gangue minerals in approximate order of deposition are: apatite, actinolite, garnet, quartz, calcite, dolomite, pyrite, fluorite, barite, and tourmaline. An important feature of the deposits, both within a single deposit and regionally, is the evidence for two periods of hematite deposition separated by a period of magnetite deposition. This sequence was noted by Tolman and Meyer (1939, pp. 1939-1940) and has been confirmed by the writer. During deposition of magnetite, much of the early hematite was reduced to magnetite. The late hematite stage not only deposited specular hematite on magnetite but altered much of the magnetite to martite. There is little doubt that the martitization was accomplished by hydrothermal activity and not meteoric waters at surface or near surface conditions.

According to Brown (1958), the Pea Ridge ore body is a tabular veinlike mass which replaces felsitic porphyry breccia. The ore body is slightly crescent shaped, strikes east-west, and dips steeply to the south. The top of the Precambrian, and the top of the mineralized zone, is encountered at depths of from 1,300 to 1,400 feet, and the deposit extends to a depth of 3,000 feet (the maximum depth at exploratory drilling).

Magnetite is the main ore mineral, but in places hematite may account for as much as 20 percent of the ore. Pyrite, chalcopyrite, and apatite are principal gangue minerals. About 60 percent of the ore is reported to be high grade (plus 60 percent Fe), and the average iron content of the ore is expected to be 50 percent Fe. The ore is amenable to concentration and contains up to 25 percent $SiO_2$ (in the low grade ore), from 0.3 to 0.9 percent S, and from 0.4 to 1.0 percent P. The sulfur occurs in pyrite and chalcopyrite; the phosphorous, in apatite. The metallurgical characteristics of the ore are discussed by Fine and Frommer in the March 1959 issue of Mining Engineering.

Two circular shafts 19 feet, 11 inches in diameter are being sunk in the footwall by the Meramec Mining Company -- a joint venture of the St. Joseph Lead Company and Bethlehem Steel Company. It is anticipated that approximately 2 million tons of concentrate will be produced annually.

At the 1,675-foot level in No. 1 shaft a crosscut has been driven approximately 850 feet to intersect the ore body. In June 1960 the ore was reached, and as exploratory drifts and crosscuts were driven the ore has been stock piled. Although the No. 1 shaft is now an all-purpose shaft, it will eventually be used for men and materials when the ore shaft (No. 2) is completed.

# EXPLORATION

## Early Exploration Methods

All of the known commercial iron deposits of Missouri, except the Pea Ridge ore body and the ore bodies now being mined at Iron Mountain, have been discovered by using surface indications. The presence of most of the filled-sink deposits and all of the brown iron deposits is indicated by concentrations of ore fragments in the surface soil. Some of the filled-sink deposits have been found by noting the sandstone rimrock which led to further exploration before the iron ore was actually discovered.

Exploration has progressed through several phases: test pits; exploratory drilling; magnetic, electrical, gravity, and air-borne magnetic surveys. Prior to 1890, the deposits of Iron Mountain and Pilot Knob were explored by drilling and several filled-sink deposits were drilled in the early 1900's.

## Sedimentary Iron Exploration

One of the earliest exploration methods, that of sinking test pits or trenches, is still applicable to the limonite deposits of southern Missouri. For exploration to limited depths, test pits are desirable because of the relatively large quantity of sample material made available and because of the erratic distribution of limonite fragments in the residuum.

Since 1955, a considerable number of brown iron deposits have been drilled by cable tool rigs, prospector's churn drills, and diamond core drills. Bucket drilling of several deposits was attempted earlier but did not prove satisfactory. Because limonite and chert boulders are scattered throughout a deposit, bucket drills and core drills do not give adequate samples. Churn drilling has been established as the most reliable drilling method.

Recent investigations by the Missouri Geological Survey indicate that electrical resistivity surveys are of value for determining depth to bedrock. The results of the field surveys, using the Wenner and the Lee modification of the Wenner system, show close agreement with bedrock depths determined by drilling. Areas of surface concentration of limonite were found to give low resistivity readings in comparison to readings taken in barren areas (Meidav, Hayes, and Heim, 1958).

In 1929, magnetic and electrical resistivity surveys were made of several filled-sink deposits by the Missouri Geological Survey, and investigations continued through 1932. Results of the magnetic investigations were encouraging in several instances. Clay and soft red hematite were found to be relatively nonmagnetic in comparison to blue specular hematite.

Churn drilling has been employed in recent years for prospecting these deposits, but samples have proved to be unreliable from zones of soft red hematite mixed with clay.

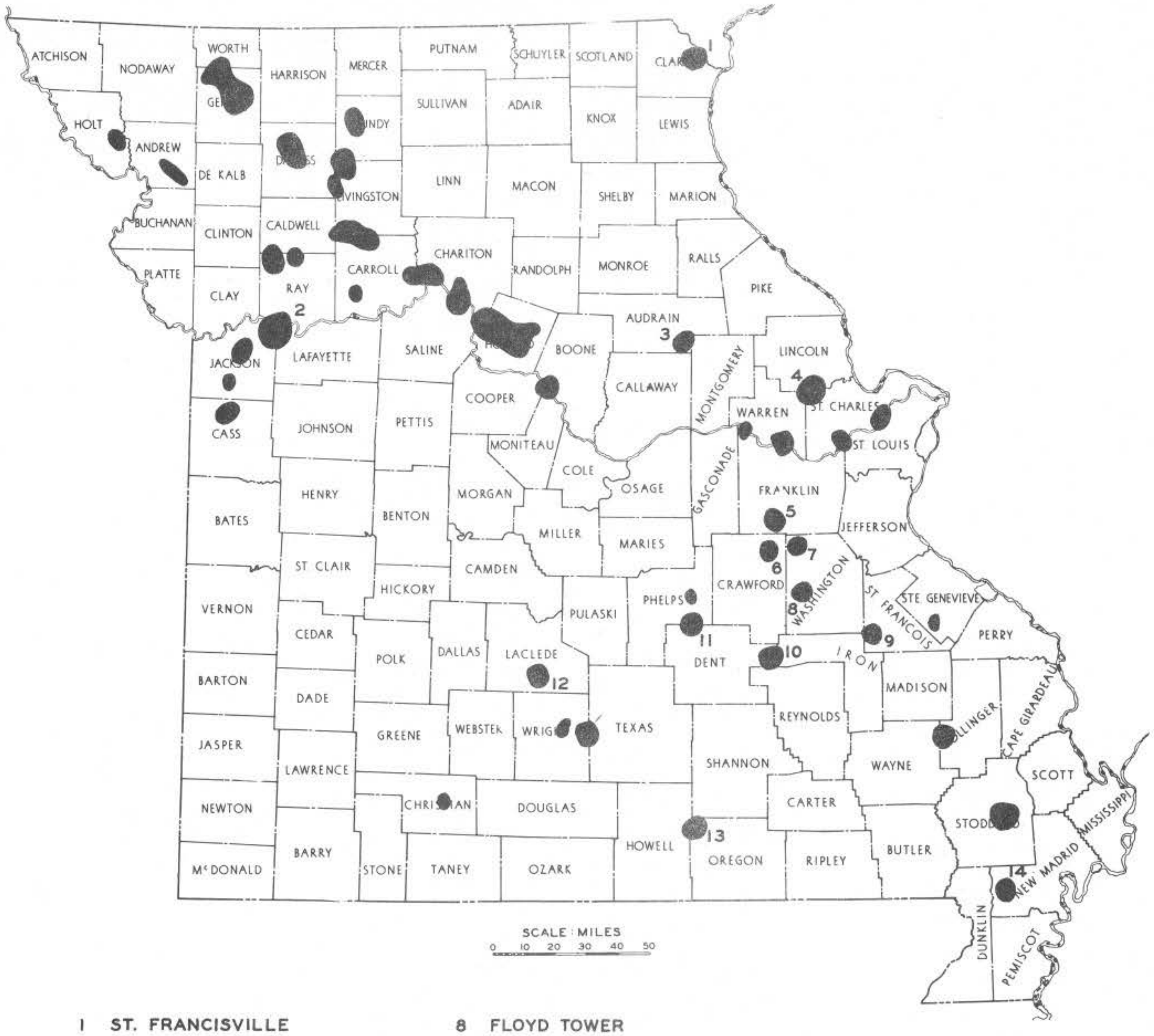
## Precambrian Iron Exploration

Shortly after the M. A. Hanna Company acquired Iron Mountain in 1927, a Gurley dip needle survey of the area was made with stations on 25-foot centers (Lake, 1933, pp. 56-67). This magnetic work facilitated the discovery of the two ore bodies currently being mined. The applied electrical potential method, using one electrode within the ore body in a drill hole and the other electrode at a distance from the collar of the hole on the surface, aided in outlining the extent of the ore.

During the past few years, the present operating company (Ozark Mining Company) has conducted extensive ground magnetic and gravity surveys in the area of exposed Precambrian rock. Complete results of their investigation are not available; however, their investigation has added considerable ore reserves.

The Bourbon anomaly was first noted by the Missouri Geological Survey in 1930 (Grohskopf and Reinoehl, 1933, pp. 14-15). In 1940, a preliminary gravimetric survey was made and a map completed in 1942. Statewide magnetic and gravimetric maps were published in 1943. The same year, electrical resistivity measurements were made by the Missouri Geological Survey, and exploratory drilling of the Bourbon anomaly was begun by the U. S. Bureau of Mines. Some of the more important anomalies in the state are indicated in Figure 2, and the Bourbon anomaly is shown in Figure 3.

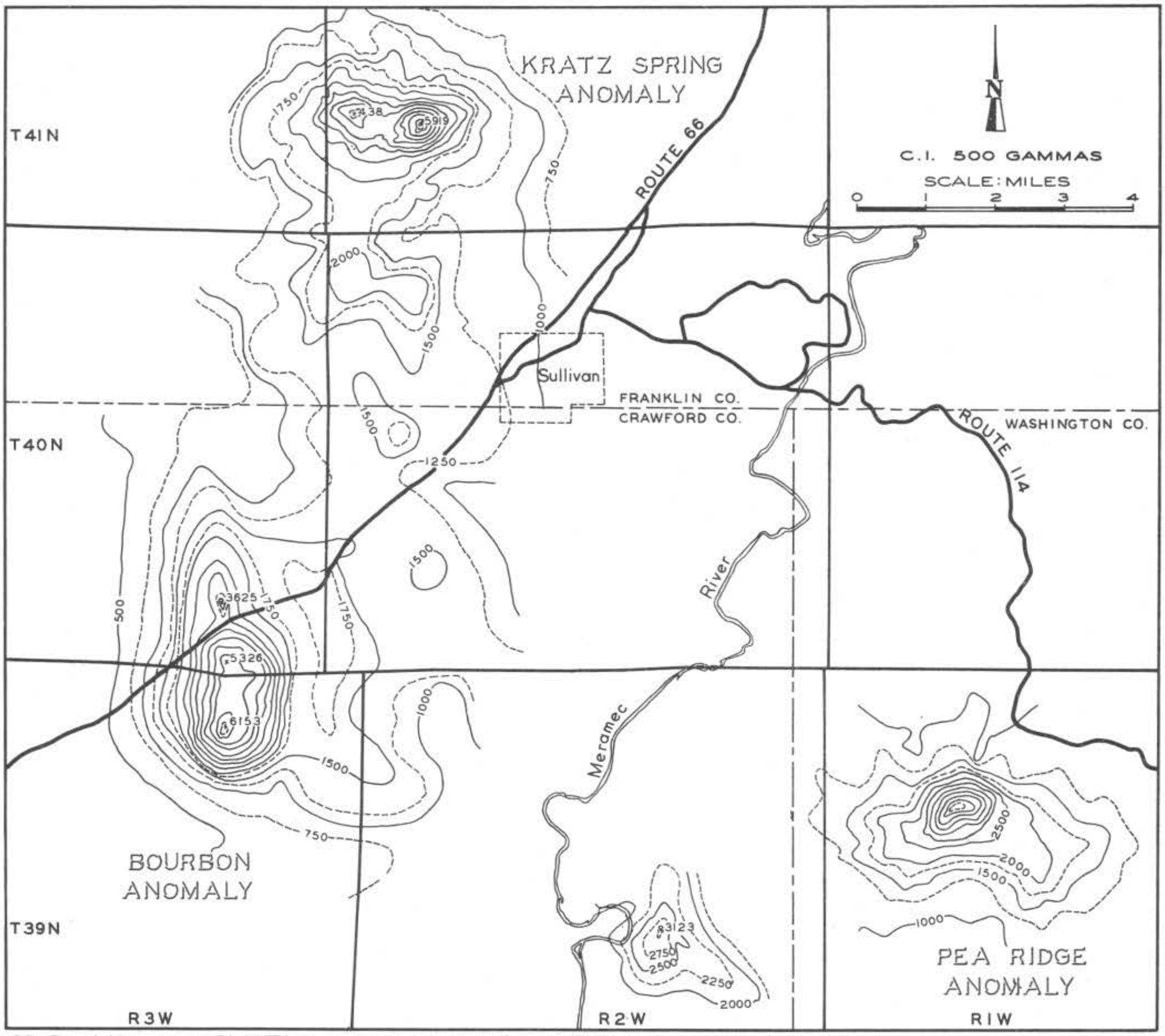
During the interim from October 1943 to November 1944, the U. S. Bureau of Mines drilled four holes on a magnetic anomaly about one mile south of Bourbon. The results are summarized in their Report of Investigations 3961 by W. D. McMillan. The Precambrian was encountered at depths of from 1,406 to 1,482 feet. A maximum of 832 feet of Precambrian rhyolite porphyry was penetrated in the drilling of the four test holes.




| | | | |
|---|---|---|---|
| 1 | ST. FRANCISVILLE | 8 | FLOYD TOWER |
| 2 | LEVASY | 9 | IRON MOUNTAIN |
| 3 | BENTON CITY | 10 | BOSS |
| 4 | WENTZVILLE | 11 | LAKE SPRING |
| 5 | KRATZ SPRING | 12 | ORLA |
| 6 | BOURBON | 13 | PEACE VALLEY |
| 7 | PEA RIDGE | 14 | MALDEN |

# MAJOR MAGNETIC ANOMALIES IN MISSOURI

FIGURE 2




GROUND MAGNETIC MAP OF BOURBON-SULLIVAN AREA
(MOD. AFTER SEARIGHT, WILLIAMS, & HENDRIX MGS RI #16)

FIGURE 3

"Hole 1 was apparently located southeast of the source of the anomaly and encountered only small stringers of magnetite. Hole 2 penetrated four mineralized zones having a total thickness of 125.7 feet and an average weighted content of 43.52 percent iron and 31.62 percent silica. These zones were tested again by a deflection hole, 2A, which gave nearly identical indications. Hole 3, 500 feet north of hole 2, penetrated 58 feet of mineralized rhyolite containing an average of 43.4 percent iron." (McMillan, 1946, p. 1.)

Since 1956 the American Zinc, Lead and Smelting Company and the Granite City Steel Company have jointly been prospecting the Bourbon area. At the end of 1960, some 18 deep test holes had been collared and most of them have been bottomed. Magnetic iron ore from 700 to 1,700 feet thick has been encountered between 1,700 and 3,500 feet below the surface. The ore is reported to be fine-grained and of a lower percentage iron than the ore in the Pea Ridge deposit. However, initial beneficiation tests have proved satisfactory for upgrading the ore to 65 percent iron.

Most of the recent exploration of the Bourbon area has been in the townsite of Bourbon, more than a mile north of the drilling conducted by the U. S. Bureau of Mines in 1943.

In 1946, the U. S. Geological Survey flew aeromagnetic surveys of the Bonneterre, Coldwater, Des Arc, De Soto, Farmington, Fredericktown, Ironton, Potosi, Richwoods, and the S 1/2 of St. Clair quadrangles. These were published in cooperation with the Missouri Geological Survey in 1949.

In 1948, the Berryman, Sullivan, and parts of Higdon, Marquand, Weingarten, and Union quadrangles were flown by the U. S. Geological Survey with that organization underwriting one-half the cost. The Missouri Geological Survey and interested mining companies each contributed one-fourth the cost. These were published in cooperation with the Missouri Geological Survey in 1951.

In April 1961, the Missouri Geological Survey published aeromagnetic maps of the following quadrangles: Augusta, Bland, Boss, Corridon, Edgehill, Hermann, Lesterville, Linn, Meta, Mokane, Morrison, Redbird, Vienna, Washington, E 1/2 of the Tavern, N 1/2 of the St. Clair, and the N 3/4 of the Union.

The Pea Ridge anomaly indicated on the Sullivan aeromagnetic quadrangle was not shown on the Missouri Geological Survey Ground Magnetic Map of Missouri (1943) due to inaccessible terrain. St. Joseph Lead Company owned 160 acres on part of the anomaly, and after acquiring some adjacent land, drilling was begun in 1949. The first hole bottomed in Lamotte at 1,100 ± feet with no shows of lead. The hole was later deepened to 1,400 feet showing some iron ore. Hole No. 2 was drilled in the hanging wall and encountered about 20 feet of magnetite ore. Hole No. 3 was drilled at the apex of the anomaly to a total depth of 2,100 feet. This hole cut 400 feet of low grade (35-40 percent Fe) ore and 270 feet of high grade (plus 60 percent Fe) ore.

In the exploration for iron deposits, the St. Joseph Lead Company has drilled several additional magnetic anomalies in the state. Two areas about a mile apart were drilled on the Kratz Spring anomaly, about 4 miles north of Sullivan. It is reported that one area consists of 45 percent iron and has a considerable number of basic dikes associated with the mineralization. The other area consists essentially of hematite which was probably formed by weathering and oxidation of magnetite. Both ore bodies are tabular with moderate dips.

A magnetic anomaly near Orla, about 14 miles south of Lebanon, Laclede County, was drilled by the St. Joseph Lead Company, and the basement was encountered at a depth of 1,817 feet. The rock is reported to be a gray green to dark green gabbro cut by minor granitic veins and to contain a considerable amount of biotite and chlorite, and minor disseminated magnetite.

The Avon anomaly, Ste. Genevieve County, was drilled by the St. Joseph Lead Company to a depth of 1,094 feet. Precambrian rock was encountered at a depth of 674 feet where a dark gabbroic and granitic material (probably diorite or granodiorite) was encountered that contains disseminated magnetite.

The St. Joseph Lead Company drilled the magnetic anomaly near St. Francisville, Clark County, where the top of the Precambrian was encountered at 2,931 feet. The rock ranges from a fine to extremely coarse-grained diorite with an appreciable quantity of amphiboles and disseminated magnetite.

Near Boss, in extreme eastern Dent County, the American Zinc, Lead and Smelting Company has drilled twelve exploratory holes, three of which indicate 100 feet of ore grade copper. All the holes have indications of iron mineralization. The top of the Precambrian was encountered from depths of 800 to 1,300 feet.

The Midwest Ore Company, a subsidiary of the M. A. Hanna Company, discovered an iron deposit on the flanks of Pilot Knob, Iron County, in 1957. Studies have indicated the economic feasibility of the property to support a benefication plant producing a sintered or pelletized concentrate.

An anomaly in extreme northeastern Jackson County, near Levasy, has been drilled by Sheffield Steel Division of ARMCO Steel Corporation and by American Zinc, Lead and Smelting Company. The top of the Precambrian in this area is from 2,200 to 2,300 feet deep.

A magnetic anomaly in western St. Charles County, near Wentzville, has been drilled by the National Lead Company, but the results are not known. The top of the Precambrian is reported at a depth of 3,120 feet.

Missouri Cliffs, Inc., a subsidiary of Cleveland Cliffs, Inc., is drilling in the vicinity of the Floyd Tower area, northwest of Potosi in Washington County.

The anomaly near Malden, New Madrid County, was drilled by the U. S. Bureau of Mines in 1945. Total depth of the hole was 3,728 feet. The Precambrian was not encountered; the hole bottomed in the Bonneterre (?) formation.

It is reported that land over the anomalies near Benton City, Audrain County, and near Peace Valley on the Howell-Oregon county line has been optioned for prospecting.

Magnetic exploration is confronted with two major problems. The extreme relief of the eroded Precambrian surface forms numerous buried topographic highs which produce anomalies on a magnetic map which may be erroneously interpreted as concentrations of highly magnetic material. An example of this situation exists in the Sullivan area. Two miles northwest of Sullivan, the Precambrian is within 25 feet of the surface, whereas the top of the Precambrian at Kratz Spring (approximately 2 miles north) is at a depth of over 1,000 feet.

The anomaly at Iron Mountain, as shown on the aeromagnetic maps, is about 1,100 gammas. Pilot Knob shows a negative anomaly of 600 gammas, Shepherd Mountain anomaly is in the order of 2,300 gammas, and the Pea Ridge anomaly is about 3,000 gammas. The ore from Shepherd Mountain contains a greater quantity of martite and magnetite than the ore from Iron Mountain. The Pilot Knob mineralization is essentially hematite and most of the ore at Pea Ridge is magnetite.

This variation in the proportion of magnetite in the ores must be carefully considered in interpretations of magnetic data. It is highly possible that future studies may confirm that certain small magnetic anomalies represent mineralized bodies in which the ratio of hematite to magnetite is high.

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