

from the dolomite wall rock being, (1) chalcopyrite largely altered to limonite, malachite and azurite; (2) barite or calcite, and (3) galena. The prospect holes which are from 4 to 20 feet deep have produced about 20 pounds of lead.

PROSPECTS IN THE GASCONADE LIMESTONE.

The Gageville Mines.—The Gageville mines, which are also known as the Hackney diggings, have been operated more extensively than any of the other mines in this county. They are owned by the Gageville Mining Co., of which G. C. Ramsey of Jefferson City is president and Joseph N. Deihl is manager. These mines are located in the W. $\frac{1}{2}$ of the N. E. $\frac{1}{4}$ of sec. 14, T. 41 N., R. 14 W. They are situated upon a north and south ridge which has been covered with shallow clay diggings. The richest prospects are reported to have been at the south end of the ridge.

In March, 1872, W. A. Hackney and John Buster opened a shaft in a sink hole 125 feet west, and 10 feet below the present main shaft. This sink hole proved to be a chimney 18 feet deep and 7 feet in diameter, which was filled with red clay carrying a high percentage of galena. At the bottom of the chimney there is a crevice striking N. 74° E., which was followed 8 feet, where it ran into a pocket of Coal Measure shale. The upper surface of the shale was followed 75 feet and the rock immediately above is said to have been very rich. Sixty thousand pounds of galena are reported to have been taken from this prospect.

From the time of this strike up to the present, more or less mining has been done on different parts of the ridge. During the winter of 1901-02 there were three drillers and from twelve to eighteen miners on the hill.

The main shaft of the Gageville mines, which is 132 feet deep, is, with the exception of 11 feet of Coal Measure shale, in the Gasconade limestone. The dolomite beds are undisturbed, although slightly wavy. Galena occurs in the dolomite throughout the entire depth of the shaft. Pockets of red clay are reported at the bottom of the shaft, although they are less abundant than at the 70 to 80 foot levels. The ore is reported to have been richest immediately above and below the shale. The rich horizon above the shale was from 5 to 20 feet thick. From 150,000 to 200,000 pounds of galena was mined from clay openings in the rock.

A drift 60 feet long, extending N. 25° E., was made to connect the main shaft with the air shaft. This drift follows approximately the contact of the Coal Measure shale and the Gasconade limestone. The dolomite in places is closely jointed and in others partly brecciated. Where cemented, the cracks are usually filled with barite.

The following section from the top down was obtained in the air shaft:

Section 26.

- 0-2 feet yellow soil containing many flint fragments.
- 2-7 $\frac{1}{2}$ feet very compact red clay with many flint fragments.
- 7 $\frac{1}{2}$ -13 $\frac{1}{2}$ feet a heavy brecciated chert bed characteristic of the base of the St. Elizabeth formation, called "Moory"* flint. It is still practically horizontal.
- 13 $\frac{1}{2}$ -56 feet heavily bedded dolomite, in some places badly decomposed, forming a dolomitic sand. Some galena occurs at the bottom of the shaft.

James Buster and David Alberson are working a shaft 80 feet north of the main shaft. At this place the following succession was noted:

Section 27.

- 0-2 feet yellowish soil and flint fragments.
- 2-10 feet compact red clay with many flint fragments.
- 10-18 feet "Moory" flint.
- 18-19 feet clay opening between the "Moory" flint and the underlying heavily bedded dolomite.
- 19-80 feet badly decomposed dolomite. Two drifts have been run at this level following joints which strike N. and S. and N. 70° E.

Although practically horizontal the rock is badly jointed and very much decomposed. Solution breccias recemented with barite are common. The galena occurs in cubes 3-4

*Winslow so spells the name. Mo. Geol. Sur., Vol. VI, p. 335.

and 20 feet deep, filled with red clay. Numerous boulders derived from the country rock are imbedded in the clay and partially rounded by solution. Other seams branch off from this main one and each is filled with clay and boulders. The galena occurs either loose in the clay or filling cracks in brecciated chert and dolomite. About 2,000 pounds have been mined.

PROSPECTS IN THE JEFFERSON CITY LIMESTONE.

The Hoff Diggings.—These diggings, known also as the Wine Sap Diggings, are located in the northeast corner of sec. 6, T. 41 N., R. 13 W., and are situated on the gentle slopes of a north and south ridge.

Mr. Adolf Schmidt,* who visited these mines when they were being operated, says that they were discovered in 1872. He says in the report referred to, that two crevices running N. E. and S. W. (by compass they strike (N. 55° E.), connected by a run at right angles were being worked. In these crevices and the numerous connected chimneys, the galena was found associated with calcite in the clay. Cerussite, known as "Mineral Clinker," also occurred in the clay with the galena. Dr. Schmidt says that from 1872 to 1874 the diggings were worked intermittently by two men producing in all 21,000 pounds of galena. Up to the present date, the production has probably been about 35,000 pounds. No mining has been done for several years.

The Olean Diggings.—In the N. $\frac{1}{2}$ of section 18, and the S. $\frac{1}{2}$ of sec. 7, T. 42 N., R. 14 W., about two miles a little south of east of Olean, from 50,000 to 60,000 pounds of galena was dug from the clay during the latter half of the 70's. This production of galena has induced several companies to sink shafts into the rock at this place. Up to the present time these explorations have not been successful.

The Franklin Diggings, located in the S. W. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$ of sec. 18, T. 42 N., R. 14 W., were worked mainly from 1875-78. Galena has been found in the clay which fills east and west crevices at this place. Cerussite is frequently found with the galena in the clay. None of these mines were over 20 feet deep. Mr. B. P. Franklin, the owner, says that 17,000 to 18,000 pounds of galena has been produced. A shaft was recently sunk in the north center of the north forty in which these diggings occur, and some lead was found in the cavities of the heavy dolomite beds. The shaft followed a crevice striking N. 82° E.

John M. Starling's Diggings, located in the S. E. $\frac{1}{4}$ of the N. E. $\frac{1}{4}$ sec. 18, T. 42 N., R. 14 W., have produced about 12,000 pounds of galena. One shaft, at present filled with water, is 90 feet deep. Galena is found mainly associated with barite, although cerussite and limonite after pyrite are common.

Long's Diggings, located in the N. W. $\frac{1}{4}$ of the N. E. $\frac{1}{4}$ of sec. 18, T. 42 N., R. 14 W., are mainly in clay. Galena and cerussite, associated with barite, occur in the clay.

The W. P. Gilleland Diggings are located in the N. E. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$ of sec. 18 and the S. W. $\frac{1}{4}$ of S. W. $\frac{1}{4}$ of sec. 7, T. 42 N., R. 14 W. Galena, cerussite and calcite occur associated together in the clay at this place. In a prospect hole in sec. 7, shale containing gypsum crystals is reported to have been passed through. Mr. Gilleland estimated the output at from 25,000 to 30,000 pounds.

The Van Meter Diggings.—These diggings are located in the N. E. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$ of sec. 18, T. 41 N., R. 15 W., and are situated in a small branch of the Little Gravois creek. A great many holes were dug at this place, the deepest of which is said to have been 52 feet. The galena was mostly found in the clay, although some is reported to have been taken from the rock. Calcite is the only mineral associated with the galena at this place. The output of these diggings has been estimated at approximately 50,000 pounds.

The Meyers Prospect.—This prospect is located in the S. W. $\frac{1}{4}$ of sec. 31, T. 41 N., R. 14 W., and is situated on the gentle slope of a high ridge. Galena, barite, calcite, chalcopryrite, limonite, malachite and azurite have been found in the decomposed dolomite along joint planes which strike N. 25° W. Crustification† is at times present. The order

*Ibid, p. 511.

†Posepny "Genesis of Ore Deposits." N. Y. 1902, p. 12.

inches in diameter, either in the clay or rock, or without barite. The cubes are usually somewhat corroded. The galena occurs in a rudely defined pipe-like body, the longer diameter of which coincides with the jointing plane. At the intersection of the N. and S. and N. 70° E. joints occur cone-shaped openings filled with very red clay. These openings are known to the miners as chimneys. From September 7, 1901, to January 18, 1902, this shaft was worked intermittently by two men who, together mined 36,920 pounds of galena.

Pinkston and Harbison have a prospect 150 yards north of this, which is situated upon an east and west run. One hundred yards west of the main shaft Johnston Bros. and Rush have a prospect in the badly decomposed dolomite. The galena occurs both in the clay and in an east and west joint.

John Buster is working a prospect 125 feet N., 60° E. of the main shaft. At this place the galena occurs through the dolomite being especially abundant above a thin layer of shale.

The heaviest deposits of ore have occurred in the upper 50 to 80 feet of the Gasconade limestone. The greater part of the ore which has been sold was obtained from the clay diggings.

Nodular cerussite, which in one instance enclosed a badly decomposed piece of galena, occurs in the clay with the galena. The galena varies in size from minute particles up to bunches weighing as much as 15,000 pounds.

Zinc blende was found in the Coal Measure shale but not in the dolomite. Barite is more commonly associated with the galena than calcite. The miners say that in this locality the white, finely granular barite is a more favorable indication of paying galena than the common white, crystalline variety.

The Gageville Mining Co. has drilled about 3,000 feet during the last year. The rate of drilling in the open ground on the hill was from 20 to 40 feet a day, while in the hard ground in the valley only from 10 to 15 feet could be made.

The output of the Gageville mines to May, 1874, according to Dr. Schmidt's* report, was 300,000 pounds. About 55,000 pounds were produced from May 1901 to March 1902. The total output will reach approximately 700,000 to 800,000 pounds.

Grass Root Diggings.—The Grass Root diggings are located in the N. W. $\frac{1}{4}$ of the S. W. $\frac{1}{4}$ of sec. 33, T. 41 N., R. 14 W. Galena was discovered at this place by Reuben Vaughn in the spring of 1872, and for two years forty men mined at this place. Since 1874 the area has only been worked intermittently.

The diggings are situated on a high, steep hill near Saline creek. The prospect holes are located on all sides of the hill, although it is reported that those on the northeast have been the richest. The main crevice crosses the crest of the hill and strikes N. 75° E. It has a width of 12 feet at the surface but narrows down to a thin seam at a depth of 20 feet. From this seam 200,000 pounds of ore was mined.

Other crevices striking N. 20° E., S. 25° E. and N. 50° W. occur at this place. Most of the galena mined at this place was obtained from red clay seams, from chimneys or from the loose clay covering the surface of the ground.

Dr. Schmidt† states that on the upper part of the northeastern slope "A shaft was sunk to a depth of 80 feet and passed through 25 feet of clay so rich in galena that 100,000 pounds were raised. The shaft then struck solid limestone with occasional seams and specks of galena and penetrated 55 feet into it, until it struck a chert layer. As the galena was very scarce and the work not paying, the exploration was stopped for the present."

The galena obtained from the Grass Root diggings was coarse "cog" mineral. Associated with the galena were some nodular masses of cerussite, barite and calcite, some of which have a rich amber color. The total production of galena has been in the neighborhood of 500,000 pounds.

The Walker Diggings.—These diggings, which are also known as the Conlogue mines, are located in the S. W. $\frac{1}{4}$ of sec. 5, T. 41 N., R. 14 W. Mr. F. V. Conlogue of Eldon,

*Report of the Mo. Geol. Sur., 1874. G. C. Broadhead, State Geologist, Jefferson City, p. 569.

†Ibid, p. 569.

Missouri, is the principal owner. The diggings are situated on the sides of the ridge bordering a branch of Saline creek. Although the upper part of the shafts are in the St. Elizabeth formation, the ore all occurs in the Gasconade limestone or the clay contained in it. This famous "circle" is a cone-shaped depression, 5 feet deep and 8 feet in diameter at the top.

Both Dr. Schmidt* and Mr. Winslow** visited these mines, the former in 1874 and the latter in the early 90's. Dr. Schmidt describes the "circle" as follows: "These shafts followed a crevice in the altered rocks and were very productive. The uppermost shafts, sunk on the summit of the spur, struck finally a very large circular deposit which is being worked at present."

Section 28.

The shafts pass through about:
 3 feet of soil.
 6 feet of fractured chert layers, with chert sand.
 10 feet clay, with chert fragments.
 15 feet hard, bluish crystalline, magnesian limestone; porous, owing to numerous denticulated cavities throughout the whole mass.

"This rock exists here in fissured layers. Below it a very large circular opening was struck, 30 to 40 feet wide above and getting rapidly wider with the depth and filled with loose, soft and wet red clay (tallow clay), in its upper part, while the lower part was filled with broken down masses of limestone more or less altered and softened, mostly angular, with broken veins and seams of barite and galena through and between them. Large cavities between the broken masses are filled with red clay. The whole mixture contained in its main portion 5 to 10 per cent. of galena, mostly slabs and chunks. The excavation has now reached a depth of 85 feet, at which depth the deposit has a diameter of nearly 80 feet. The walls are in some places very marked and cut off the galena; in other places, however, thick seams of galena run into the moderately hard wall rock. Some of these have been followed to a distance of over 30 feet. Seams of galena also extend to a greater depth, but the rock appears to get harder and more solid."

Mr. Winslow states, "The galena as seen in the undisturbed pillars is firmly imbedded in calcite or barite lining cavities. Sheets of barite were seen attached to the wall of the chamber, and galena is said to have been found in similar sheets both attached to the surfaces and penetrating crevices in the wall and floor."

At present a tunnel extends along an east and west crevice from a branch of the bottom of the "circle." Some galena is exposed along this tunnel. In places the country rock forms a solution breccia. The ore-bearing zone is vertical and about six inches wide.

The main crevices in the Walker diggings have a strike of from N. 85° E. to E. and W. A second less important series has a strike of N. 35° W.

The barite at this mine is unusually abundant. Excellent transparent crystals and pseudomorphs of barite after calcite are common. Some are marked with dendrites of manganese oxide. Amber and amethystine-tinted calcite is abundant. Chalcopyrite and its alteration products are common. Although most of the ore was galena, about 400 pounds of cerussite has been obtained.

The order of crustification of the country rock is as follows: (1) Chalcopyrite, largely altered to malachite; (2) Crystalline barite; (3) Chalcopyrite; (4) Crystallized barite.

In the S. E. $\frac{1}{4}$ of the S. W. $\frac{1}{4}$ of sec. 5, T. 41 N., R. 14 W., thin seams of galena striking S. 89° E. and N. 50° W., occur in the dolomite.

Dr. Schmidt† places the output at the time of his visit at about 1,000,000 pounds. The men who mined here at that time were interviewed during the present season and without exception their estimate of the output was from 350,000 to 800,000 pounds.

The Fox Diggings.—The Fox Diggings are located in the N. W. $\frac{1}{4}$ of sec. 31, T. 41 N., R. 14 W. These diggings, which are said to have been opened in 1871, are situated on the sides of a ridge capped by the St. Elizabeth formation.

*Ibid, p. 567.

**Mo. Geol. Sur., Vol. VII. C. R. Keyes State Geologist, Jefferson City, 1894. p. 707.

†Ibid, p. 568.

The greater part of the galena mined was found in the clay within 10 feet of the surface and in crevices and chimneys. Mr. Edward Spaulding, to whom we are indebted for this information, stated that apparently the galena pinched out upon reaching the rock.

The trend or the strike of the crevices in these diggings varies greatly. The following is the strike of some of the ore-producing crevices: N. 8° E., N. 55° E., N. 70° E., N. 85° E., N. 75° W., N. 57° W.

The galena occurred in unusually large bunches, one of which weighed 7,000 pounds. Calcite and cerussite both occur with the galena.

The Tate company of Enon sunk a shaft at this place in the summer of 1901. It was filled with water at the time that part of the county was being surveyed and therefore could not be examined. The dump pile showed some shale which resembled lithologically the Coal Measure shale of this region. Mr. Spaulding stated that this shale was found about 30 feet below the surface. In some places it pinches out and in others it is 3 feet thick. Above this shale the ore is reported to be good. The output of these diggings has been in the neighborhood of 175,000 pounds.

McBride and Lawson Diggings.—Messrs. McBride and Lawson own several groups of diggings in the N. W. $\frac{1}{4}$ of sec. 24, T. 41 N. R. 14 W.

In the northwest corner of this section there are a number of prospect holes situated 10 to 15 feet below the St. Elizabeth-Gasconade contact. Galena was discovered here by Mr. Alberson ten years ago. The ore occurred in clay near the top of the ground and in openings in the rock. It was associated with calcite, barite and iron pyrite. One opening, striking N. 5° E. contained a flat deposit of galena one yard wide and from one-fourth of an inch to six inches thick.

In the west central part of the northwest quarter of the same section, occurred a rich run of ore 40 feet below the Gasconade-St. Elizabeth contact with a general north direction, (the majority of the readings being N. 5° W.) Mr. Alberson reports that the ore was mostly in clay, the pay dirt being from four to ten feet wide and from two to three feet deep. The width of the deposit seemed to have no effect upon the quantity of ore. The ore which at times went under bridges of solid rock was followed 150 feet into the dolomite. In the rock the clay opening was in places 6x7 feet, while at others it was almost completely closed by dolomite boulders known to the miners as "key rocks." In one place where a "key rock" was removed from the opening, a cave seven feet high and fifteen feet long and five feet wide was encountered. Hanging from the cap rock of this cave were stalactites of block galena, some weighing 500 pounds. The floor of the cave was filled with four feet of clay and lead, the latter of which had fallen from the roof. No galena was found attached to the rock on the bottom of the cave. In the narrower portions the ore occurred in horizontal and vertical sheets, usually the former.

Galena is said to have been present in the rock as far as the tunnel extended. One piece of galena was found which weighed 997 pounds. Large pieces of calcite were commonly present in the rock, although very little occurred in the clay. Much of the calcite has a beautiful amber tint. These diggings were apparently abandoned because the blasting which is required in the hard ground was too expensive.

In the center of the northwest quarter of the same section and across the ridge from the diggings above described, Mr. Alberson prospected along an opening striking N. 65° W. After following this opening 75 yards a cross seam striking N. 12° W. was encountered. Both of these openings produced galena, which occurred mainly in the clay. These deposits occur 40 feet below the contact of the Gasconade and St. Elizabeth formations. Barite, cerussite and calcite are associated with the galena.

In the north middle of the S. E. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$ are several prospects known as the Whip-poor-will Diggings. The openings at this place have a strike of N. 80° E. to S. 80° W. The galena occurs associated with barite of two generations.

The combined output of these diggings is estimated by Mr. McBride at 250,000 pounds of galena. Of this amount 150,000 pounds have been produced during the last seven or eight years.

The Curty Diggings.—The Curty diggings are located in the N. E. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$ of sec. 11, T. 41 N., R. 14 W. They are situated on the sides and bottom of a rather steep gulch and are from 10 to 70 feet below the top of the Gasconade limestone.

The lead occurs in clay openings in the rock and in badly decomposed dolomite. Most of the openings strike N. 85° E., although one was observed which had a strike of N. 10° W. Small areas of brecciated flint were observed at this place. The ore is mainly galena, although cerussite is of common occurrence. A gray variety of cerussite, having the appearance of badly corroded galena, is commonly known by the miners as "burnt" lead. Calcite is commonly associated with both the galena and cerussite.

These diggings were discovered in 1871 or early in the spring of 1872, since which time they have produced approximately 200,000 pounds of galena.

Loveall Diggings.—These diggings are, with perhaps one exception, the oldest in Miller county. Meek* apparently mentions them when he says "In the S. W. $\frac{1}{4}$ of sec. 2, T. 41 N., R. 14 W., in the bed of a small branch of Saline creek, about 150 feet below the summit of the country. I saw, in some gray layers of Second Magnesian limestone, occasional crystals of lead ore; and Mr. Belche informed me he has picked up loose, in the bed of this creek, near here, several hundred pounds of ore. It does not appear to exist here in a fissure, but is disseminated in the form of isolated crystals through the rock."

As early as 1858, Mr. Temple E. Bell had two negro slaves working the tract and he is said to have gotten out a few thousand pounds. Two years ago considerable work was done on these diggings, but since then they have been worked intermittently.

The diggings are situated in the center of the S. $\frac{1}{2}$ of sec. 2, T. 41 N., R. 14 W., along the gently sloping sides and bottom of a small tributary of Saline creek. They are in the Gasconade limestone within 40 feet of the St. Elizabeth-Gasconade contact.

The galena occurred scattered through the clay on the top of the rock and in a "chimney" or "circle" in the stream bed. This was the site of the recent work mentioned above. The "circle" at the surface is 100 feet from east to west and 65 feet from north to south. It gradually contracts towards the bottom, and at a depth of 60 feet its dimensions are less than half those of the surface. The "circle," which was originally filled with clay and rounded boulders of dolomite and chert is now filled with water. The best ore is said to have come from within 3 to 4 feet of the circular walls. The galena from this part of the circle varied in size from a pea to that of one's fist. In the center of the circle the galena was more sparsely disseminated, although in larger masses. The ore is all galena and the gangue consists of two generations of barite. Some galena associated with oölitic chert has been clearly derived from the St. Elizabeth formation. In the neighboring clay diggings some cerussite has been found. North of the "circle" is a deposit of Coal Measure shale in which are boulders containing blende. No blende is reported from the "circle."

The output of galena from these diggings has been approximately 45,000 pounds, of which 25,000 pounds was obtained two years ago.

The Indian Grave Diggings.—These diggings are located in the N. W. $\frac{1}{4}$ of sec. 14, T. 41 N., R. 14 W., on a gap in a north and south ridge, 20 feet below the top of the Gasconade limestone. The diggings were named from two huge piles of dolomite boulders 20 feet in diameter and 5 feet high, clearly marking Indian graves. The galena was found in the black soil and white dolomitic sand, filling crevices striking N. 70° E. The prospect holes were not over 15 feet deep and the galena crystals occur associated with barite.

These diggings were abandoned when the Gageville mines were discovered, and have been worked very little since. The output is placed at 10,000 pounds.

The Melton Diggings.—These diggings are located in the northeast corner of sec. 23, T. 41 N., R. 14 W., on a gentle hill slope from 0 to 60 feet below the base of the St. Elizabeth formation. The galena was found in clay openings and chimneys. The more important crevices strike N. 75° E., N. 12° E. and N. 33° E. Exceptionally pure calcite and two generations of barite are found with the galena.

*Geol. Sur. of Mo., 1855-74, p. 132.

Mr. Winslow* gives the output as 50,000 pounds.

The Swallow Diggings.—These diggings are located in the S. W. $\frac{1}{4}$ of sec. 14, T. 41 N., R. 14 W., and have produced about 20,000 pounds of ore. The ore occurs in clay crevices, striking N. 83° E., and about 60 feet below the top of the Gasconade limestone. The galena is associated with barite of two generations.

In the center of the east half of the same quarter, are some diggings 40 feet below the top of the Gasconade limestone. The galena occurs in clay.

The Blackburn Diggings.—These diggings are located in the N. E. $\frac{1}{4}$ of sec. 10, T. 41 N., R. 14 W., on G. L. Wimmial's farm. There are two distinct mining tracts. One is on a gentle slope of the valley of the north Little Saline and about 100 feet below the top of the Gasconade limestone. Here the ore occurs imbedded in clay openings in the intercalated flint of the Gasconade limestone.

The second tract, from which most of the galena has been obtained, is from 0 to 40 feet below the top of the Gasconade limestone. The ore occurs in the rock and in clay openings, and is associated with amber or lemon-colored calcite, in pieces as large as one's head. One crevice strikes N. 45° E. The total product of these diggings is in the neighborhood of 150,000 pounds.

Compton Diggings.—The Compton diggings are located near the center of the S. E. $\frac{1}{4}$ of sec. 8, T. 41 N., R. 14 W., in the upper 100 feet of the Gasconade limestone and are situated on the slope of the valley of the Walker Mines branch of Saline creek. Both calcite and barite occur associated with the galena. The crevices, which strike N. 60° E., are filled with clay in which the galena occurs. The mines have been worked intermittently from the early seventies until 1901. In 1900, some 4,000 pounds were produced. Mr. H. M. Compton, the owner gives the total product as 33,000 pounds.

In the western part of the N. E. $\frac{1}{4}$ of the same section, in the upper 80 feet of the Gasconade limestone, occur other old diggings. One set of crevices strikes N. 55° E., and another N. 12° W. The ore is in red clay and is associated with barite. The product is said to have been 5,000 pounds of lead and 33 tons of barite. During 1901, a shaft was sunk 72 feet through decomposed dolomite containing clay pockets. Galena was encountered in seams in the dolomite. Barite was abundant in the intercalated chert beds, some of which are brecciated. Calcite is present but not associated with the galena. From the 44 foot level to the bottom of the shaft some blende was encountered. Above the 44 foot level a few crystal casts, apparently of blende, were found in the barite. Iron pyrite, chalcopyrite and its decomposition products, limonite and malachite, also occur.

From a mass of dolomite 4x8x10 feet in the south center of the same section, Mr. Compton has cleaned 700 pounds of ore. The dolomite was exceedingly open and the lead, associated with calcite, occurred disseminated throughout the mass. Malachite stains were noted.

PROSPECTS OUTSIDE OF THE SALINE CREEK DISTRICT.

Johnston Bros.' Prospect.—In the S. W. $\frac{1}{4}$ of the S. E. $\frac{1}{4}$ of sec. 24, T. 41 N., R. 13 W., Johnston Brothers recently mined 920 pounds of lead from the clay in a N. 72° E. crevice. This prospect is situated on a "ball" about 30 feet below the top of the Gasconade limestone. The dolomite is, in places, very much decomposed. The galena occurs with barite and limonite, the latter an alteration product of pyrite. Thin seams of galena penetrate the limestone on either side of the opening.

Hutchison's Prospect.—This prospect is located on William Hutchison's land in the S. W. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$ of sec. 3, T. 40 N., R. 16 W., in the upper 40 feet of the Gasconade limestone. A St. Louis company, several years ago, sunk two shafts on this place, one 20 and the other 45 feet deep, and connected them with a drift. The dolomite is very open, much jointed and badly decomposed. Breccias, cemented with calcite, were observed. The ore occurs in the soft dolomite. Running nearly at right angles from the main crevice are many seams containing some galena.

In a gulch 100 feet north of these shafts, galena has been found in the clay and brecciated chert about 70 feet below the top of the Gasconade limestone.

Galena was first found at this place about ten years ago and the production has been about 3,200 pounds.

*Mo. Geol. Sur., Vol. VII, Jefferson City, 1899, p. 709.

The Waite Prospect.—In lot 3, N. W. sec. 3, T. 39 N., R. 13 W., on the slope of Barren forks, is a prospect hole 10 feet deep, on a N. 75° E. crevice. The shaft is on the crest of a gentle anticline and in the upper 30 feet of the Gasconade limestone. The dolomite is rather siliceous and contains thin, blue, shaly parting planes. Along the bedding planes occur layers of barite and calcite, one to three inches in thickness. These minerals also occur in the numerous cavities in the limestone. Blende occurs sparsely disseminated through the dolomite and associated with the barite. Some of the blende has been altered to brownish, mammillary smithsonite. Chalcopyrite and its decomposition products, limonite, malachite and azurite, occur with the barite. While in some instances the chalcopyrite is surrounded by barite, as a rule, it is next to the country rock and the barite incrusts it. Small particles of galena occur in the barite.

At the foot of the slope, fifteen feet below the shaft, there is a two and a half foot bed of black and bluish chert. The cavities in this chert are mainly filled with barite, although some galena is reported to have been found.

On the Little Tavern in lot 6, N. W. sec. 2, T. 39 N., R. 12 W., in the upper 20 feet of the Gasconade limestone, is a clay seam striking N. 80° W., in which galena was found. Galena is also reported at the bottom of the crevice and in the wall rock.

Two hundred yards south of the last prospect, in the northwest corner of the W. ½ of lot 5, N. E., is another prospect on land owned by Mr. Whitaker. This prospect is on a N. 35° W. crevice, 10 feet long and 2 feet wide, in the upper 40 feet of the Gasconade limestone. The sides of this pocket-like opening are coated with blende. Iron pyrites and barite are abundant. The order of crustification is (1) country rock, (2) limonite (after marcasite or iron pyrite), (3) blende, (4) barite. Mr. Whitaker reports that a vein of blende and barite which has never been worked dips under the creek at this place.

The Rothwell Mine.—This mine is located in the W. ½ of lot 5 N. E., sec. 2, T. 39 N., R. 12 W. It is situated 20 feet above the bed of Little Tavern creek and in the upper 40 feet of the Gasconade limestone. The ore is blende, some of which has been altered to smithsonite. It is associated with a little marcasite and pyrite and considerable barite. At the time the mine was visited, the shaft could not be entered, so that it is necessary to incorporate the following from Winslow's* report: "The adjoining sketches illustrate the conditions of occurrence. The vertical gash vein, illustrated in A, is traceable in a sinuous line across the bottom of the pit and up its two sides, a horizontal distance of about 4 feet. It pinches out at the top. In a flat opening on the western side, a little above the vertical deposit, a mass of galena and barite about a foot in diameter was found. Some galena occurred mixed with the blende in several openings, and also some copper pyrites and smithsonite. The surface of the magnesian limestone at the contact with the ore is generally stained a red color."

Stark's Prospect.—Stark's prospect is located in the S. W. ¼ of the S. E. ¼ of sec. 17, T. 40 N., R. 13 W. A small seam of galena along a bedding plane of the Gasconade limestone, dipping 60°, S. 70° W., has been mined. This seam varies from a mere knife edge to a sheet 5 inches thick. Calcite, which is apparently older than the galena, occurs with it. In other places in this vicinity, galena has been found both in the clay and in the dolomite. Mr. Stark reports that 300 pounds of galena have been mined from this prospect.

The Stevens Mine.—In the southeast corner of sec. 23, T. 40 N., R. 14 W., in the upper 100 feet of the Gasconade limestone, the Central Missouri Mining and Mineral Company sunk a shaft 87 feet deep, on land owned by Joshua Stevens. The shaft is situated in the bottom of a small ravine and is at present filled with water.

At a depth of 22 feet, blue flint carrying blende and chalcopyrite was penetrated. At 43 feet, a 2-foot bed of cherty dolomite, in which a little galena and blende is imbedded, was passed through. From 43 to 87 feet the rock is reported to be barren. In places, breccias, probably solution breccias, occur, in which the fragments have been cemented together with barite.

*Mo. Geol. Sur., Vol. VII, p. 709.

The ore, which is mainly blende, occurs both alone and with barite. Chalcopyrite is frequently present and is clearly older than the barite. In places stellate aggregates of pink and gray crystals of dolomite line the cavities. The order of crustification is (1) country rock, (2) crystallized dolomite, (3) chalcopyrite, (4) barite.

In the bed of Cattail creek, just east of the mine, is a white dolomite, containing disseminated black chert, thin seams of barite, chalcopyrite, blende and galena. This is the ore horizon of the 22-foot level in the mine. This dolomite contains great chert concretions two to four feet in diameter and one to two feet in height. The outer layer is a blue or black barren chert, while within there is a confused mass of dolomite, blue or black chert, barite, blende and galena. The mass has apparently been formed by the removal in solution of the more soluble portions of the chert and dolomite and the subsequent infiltration of barite, galena, blende and pyrite. Nearly all of the pockets at the surface have been worked out. This mine has produced about 300 pounds of mineral, while about 400 pounds of galena and blende together have been obtained from the flint concretions.

Capp's Diggings.—These diggings are located in the N. W. $\frac{1}{4}$ of the S. W. $\frac{1}{4}$ of sec. 7, T. 40 N., R. 13 W. They are situated in the upper portion of the Gasconade limestone. They were worked before the Civil War and, at that time, a small lead smelter was operated in connection with them. They were reopened in the 70's and have been worked intermittently ever since. The property has changed hands several times and is now being worked by the Kansas City Mining Company. Practically all the ore so far produced has been derived from the clay on top of the rock and in crevices. Some work has been done in the solid rock with indifferent success. Calcite and some barite are associated with the galena.

Schmidt* places the total product at from 30,000 to 40,000 pounds.

The Pope Diggings.—These diggings are located in the N. $\frac{1}{2}$ of sec. 6, T. 40 N., R. 12 W., in the upper eighty feet of the Gasconade limestone. Galena is reported to have been found in the soil on the hillside and in places thin seams of galena occur in the rock. A crevice three feet wide and striking N. 70° E., occurs at this place. It contains a vein of lead varying in thickness from a mere knife edge to 3 or 4 inches. On the north side of the hill a crevice was worked which had a strike of N. 65° E., and a dip of 5° N., 25° W.

The diggings are situated on both the north and south sides of the hill. The badly decomposed dolomite in which the lead occurs contains a few thin partings of greenish blue shale.

In 1900 a shaft was sunk 25 feet deep, which passed through a bed of black chert at a depth of 15 feet. It is reported that, at the surface, in the vicinity of this shaft, galena was especially abundant, while deeper down the mineral almost entirely disappeared.

On the south side of the hill barite is abundant in the clay, while on the north side both calcite and barite are abundant. The rocks in the vicinity of the shaft contain many very thin seams of galena.

Near the middle of the N. $\frac{1}{2}$ of sec. 6, T. 40 N., R. 12 W., below the above mentioned black flint layer, galena occurs in thin sheets along the bedding planes of the dolomite. Clay pockets carrying large sized pieces of galena, calcite and barite occur at this place.

In the bed of a small ravine in the N. E. $\frac{1}{4}$ of sec. 6, T. 40 N., R. 12 W., lead occurs in knife edge seams which strike N. and S.

It was impossible to approximate the former output of these old diggings. In 1900 about 15,000 pounds of galena were produced.

GALENA AND BLENDE IN COAL.

Swallow** and Meek** mention the occurrence of galena and blende in the coal pockets of Central Missouri. Winslow† in his discus-

*Rep. of the Geol. Sur. of Mo., 1873-74, Jefferson City, 1874. G. C. Broadhead, State Geologist, p. 570.

**First and second annual reports of the Geol. Sur. of Mo. G. C. Swallow, State Geologist, Jefferson City, 1855, pp. 91, 192, and Meek's Rep. same Vol., p. 113.

†Mo. Geol. Sur., Vol. VII, Jefferson City, p. 486.

PROSPECTS IN THE COAL MEASURE SHALE.

The Little Nugget Mine.—The Little Nugget Mine is located in the N. W. $\frac{1}{4}$ of sec. 15, T. 41 N., R. 13 W. Galena and blende occur in two distinct ways, first disseminated through the shale, and second filling cracks and crevices in the imbedded boulders. The first method of occurrence is the more common. The dissem-

minated crystals vary from one-half to one-sixteenth of an inch in diameter. Galena predominates. The galena crystals are a combination of the cube and octahedron. On some of the cube faces vicinal octahedral faces form a slightly raised truncated pyramid. Blende is crystallized in fine trisoctahedrons. The blende is a high grade "rosin jack." Crystals are especially abundant in some parts of the clay, while in others they are entirely wanting. The perfection of both the galena and blende crystals is due to the slight resistance which the soft shale offers to the crystallizing forces. Since the shale is quite insoluble it is thought that the sulphides, in forming, forced the plastic shale aside to make room for the growing crystal.

A crystal of blende exactly similar to those occurring in the shale was found imbedded in a piece of Upper Burlington limestone. The removal of the blende crystals left perfect casts of the crystals in the limestones. These crystals probably assumed their present position after the Upper Burlington limestone was deposited in the Coal Measure pocket. Not only are they mineralogically like the blende in the shale, but their position in the limestone was such that if they were of earlier origin they would either have been knocked off or somewhat altered by erosion and weathering. One of two explanations seem most possible,—either the force of crystal growth was sufficient to crush the limestone into a rude approximation of the crystal form after which the limestone was cemented around it, or the limestone was removed by solution as the crystals grew.

The "dice mineral" and "strawberry jack" are disseminated throughout the shale pocket. Mr. John Holtzhauser, the superintendent, states that ore was most abundant at the 40-50-foot level, the best being at 45 feet.

Galena and blende are also found in the cavities of chert, dolomite and limestone boulders. The ore in the concretionary cherts is often in concentric rings, occupying cavities formed by the removal of soluble layers. Barite and calcite also occur in cavities cementing the brecciated sandstone and limestone. Some iron pyrites occur in the crevices.

Galena also occurs on the surface and in the open crevices of sandstone and limestone boulders, especially in the case of the former. (See plate XVII.) In such cases it is usually associated with crystallized and crystalline barite, the latter of which is the older. At least a part of the galena is older than the barite.

As before mentioned, the country rock in the vicinity of the mine is considerably disturbed. Breccias occur, the cementing material being both calcite and dolomite.

All the ore in the main shafts, although above water level, is absolutely fresh. A small prospect seven feet deep showed some lead cubes slightly corroded. The freshness of the ore is due to the slow circulation of the water, resulting from the impervious character of the shale and the deoxidizing effect of the carbonaceous matter in the shale. Surface water circulating slowly would soon lose its oxidizing power in this highly carbonaceous shale.

The mine is on R. L. Morgan's land and is leased by the Little Nugget Mining Company of Jefferson City. This company has one well-timbered shaft 135 feet deep; a second shaft 48 feet deep, in the disturbed rock at the edge of the deposit; and a third, which is at present being sunk. About 7,000 pounds of galena have been washed from the shale and sold.

The McClure Prospect.—(See Fig. 55). The method of occurrence of the ore in this prospect is similar to that at the Little Nugget mine. Blende is the predominant ore and it occurs in crystal aggregates from three-quarters of an inch to two inches in diameter. It is usually a high grade rosin jack. In places galena is associated with the blende.

Galena and blende occur in the crevices of the various boulders, being especially common in the concentric cavities of the concretionary cherts. The ore is all fresh, showing little evidence of weathering. The small bits of carbonaceous material, previously referred to as scattered throughout the shale, have formed the nuclei around which the "strawberry jack" has been precipitated. (See fig. 56). In those pieces in which traces of the carbonaceous material still exist the crystals of the aggregate radiate from the carbonaceous material in much the same manner as the separate seeds of a fir cone radiate from the stem. There is every gradation, from crystal aggregates in which the carbonaceous matter predominates to those in which it is entirely absent. Often a crystal aggregate which shows no carbonaceous material on the exterior encloses a bit of vegetable matter in its interior. About one piece in four still contains carbonaceous matter but the

mineralogical character of all is so uniform that a common origin is probable. This is a striking example of the influence of organic matter in the precipitation of zinc sulphide.

The fossil nuts before mentioned (page 106), have exteriors of iron pyrites and interiors of sphalerite. In one case the blende in its growth appears to have broken the earlier formed shell of iron pyrites.

Iron pyrites is not especially abundant. In some cases, where the galena and blende occur in seams, it is present as a thin film between the rock and the ore. It also occurs at the bottom of the Saline Creek cave-conglomerate, increasing in quantity with depth.

The dryness of the mine, until it reached the bottom of the shale, has been mentioned before. Drill holes in the limestone, on the east side, show some water, while those in the shale are dry. Mr. McClure reports that in the drill-hole sunk in the coal mine, water was encountered at 60 feet, lost at 110 feet and regained at 130 feet. This water filled the drill-hole to within 30 feet of the surface and is very peculiar, as the shaft, which was absolutely dry until the last drill-holes were put down, is but 40 feet northwest of the coal prospect. Possibly the drill may have penetrated the edge of the deposit. In a well in the Jefferson City limestone, 500 feet northeast of the mine, water stands within 25 feet of the surface. Taking into account the difference of elevation, the water level at the well is 125 feet above that at the mine.

Mr. McClure reports that the cuttings from 20 feet of the lower 30 feet of the trial drill-hole would average 20 per cent. in blende. The shaft is 136 feet deep and is all timbered. A horse power hoist has been used in sinking, although at the time of our last visit, a steam hoist and pump were being installed. As yet no ore has been sold.

The Sight Me Prospect.—For location, geology and water conditions see page 107.

This prospect, which is located on the Foote land, was worked during the winter of 1901-02 by the "Sight Me Mining Company," of Kansas City. The ore is mainly blende. Galena and blende occur principally in cavities in boulders. The galena is mainly confined to the chert boulders, although a few pieces were found in sandstone. The blende occurs in "cotton rock," dolomite, chert and sandstone. Some crystals were noticed in the shale. In one place a small sheet of blende was observed occupying a joint perpendicular to the bedding in the shale. On account of the sparsity of joints in the shale, such occurrences are uncommon.

Mr. McLaughlin* states that this mine, under the former management, produced in 1898, 1,000 pounds of blendes.

The Son Prospect.—The location and geology of this prospect have already been described on page 108.

The ore is mainly blende, which occurs in concretionary chert and as a cement in certain apparently brecciated cherts. This prospect was worked by the Central Missouri Mining and Developing Company of Kansas City, during the winter of 1901-02. The development consisted of drilling three holes, from which rich cuttings are reported, sinking a 33-foot shaft and running two short drifts.

No water was struck in the last drill-hole down to a depth of 100 feet. At this point a strong stream was encountered which flowed out at the top. The shaft was flooded when the drift cut into this drill-hole.

Joseph Cotton's Prospect.—(See page 103). This prospect contains blende, both as "pebble" jack in the shale and as sheets parallel to the bedding planes in the cannel coal. Galena also occurs to a less extent in the shale and cavities in the flint boulders. A piece of grayish, calcareous chert with attached blende crystals was found, in which the blende crystals had made a perfect impression. There seem two possible explanations for this phenomena—either the chert is younger than the blende and so formed around the blende, or the crystallizing force of the blende was strong enough either to impress its crystal form into the chert or to control the solution of the chert sufficiently to form a cast of the blende crystals in it. The chert seems to grade into a siliceous dolomite, the whole resembling closely the chert and dolomite noted in various places in the lower portion of the Jefferson City formation, for example, sec. 11, T. 42 N., R. 15 W. One is inclined to regard the latter explanation as the more probable.

E. A. Watt's Prospect.—This prospect is located in the west center of the S. E. $\frac{1}{4}$ of the N. W. $\frac{1}{4}$ of sec. 1, T. 41 N., R. 16 W., along a small tributary of the South Moreau. The shaft was sunk on the contact of the Jefferson City formation and the Coal Measure shale. Both galena and blende in the form of pebble ore were found in the shale while the pits in the decomposed dolomite forming the foot wall carried considerable blende.

In the N. E. $\frac{1}{4}$ of the N. E. $\frac{1}{4}$ of sec. 7, T. 42 N., R. 15 W., in a stream bed, L. G. Berkley has sunk several ten-foot holes in a small deposit of Coal Measure shale apparently occupying a crevice in the Jefferson City limestone.

The dolomite surrounding the shale is very much decomposed and is full of very fine grained blende. At the surface the blende is replaced by smithsonite (zinc carbonate), or is represented by crystal casts.