INTRODUCTION.

The Joplin district lies between 94° 15' and 94° 45' west longitude and 37° 11' and 37° 35' north latitude, including about 15 minutes quadrangles.

The average length from east to west is about 27.6 miles and the width from north to south is 17.2 miles.

The Joplin district was surveyed during the field season of 1901 and parts of the field season of 1902 and 1903. Some time has necessarily elapsed between the field investigation and the present report, and many minor changes have, of course, taken place in the district. These, however, are of such a nature that the writer believes they will not materially affect the value of the text.

Unless otherwise noted, the determinations of fossils and the microscopical features are given on the authority of Dr. George H. Gill.

Lithology. The number of published papers dealing with the Ozark region, especially with the ore deposits of the Joplin district, is considerable. Bibliographies, including the earlier works relating to the region, are given in the following papers, that of Kreyes bringing the record down to 1905.


SURVEY, 1901, pt. 2,1901, pp. 69-75.

General statement. The lead and zinc deposits of the Ozark region occur in three groups.

1. The deposits of the Joplin district, which has been described in an earlier report.

2. The deposits of the southeastern Missouri district, which is largely by Mr. Siebenthal. The deposits of this district are referred to in the two preceding sections and in the map.

3. The deposits of the northeastern Missouri district.

To the northeast, then to the south not far from the margin of the Ozark uplift, and finally outward, is the Joplin district.

The ore deposits of the three districts of the Mississippi Valley are distinguished from one another by certain differences both in the form and structure of the ore bodies and in the mode of occurrence and development of the ore minerals. The Mineral Region, the Joplin district, is characterized by the absence of well-defined lenses and by the common occurrence of the ore in large bodies of slight horizontal extent known as "runs," or in comparatively thin layers associated with the "blankets" or "sheet rock". The deposits of the three districts are very much disturbed by the underlying rock structure and texture. Except along the short southern slope of the uplift, the all the important structures of the region have developed normal.

Geology of the Ozark uplift. The Ozark uplift is a low dome of elliptical outline, and its eastern margin is a table-land bounded by the Ozarks. The uplift as a whole is about 400 feet higher than the surface of the Ozarks. The uplift is bounded on the west by the Ozark Mountains and on the east by the Ozark Plateau.

The height of the upland surface of the district amounts to little more than 400 feet. The northern continuation of the upland in the vicinity of Joplin is shown on Fig. 5, which gives a geological section through the district. The highest point of the upland, about 140 feet above the general surface level, is on Spring Hill, a few miles north of Joplin. The lowest point, about 775 feet in altitude, is on Spring Hill, a few miles north of Joplin.

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abundant water. They rise outside the district, but in their courses across it receive important additions.

Nearly all the numerous valley tributaries in these three principal streams are comparatively narrow and short, and the larger ones, with a few exceptions, do not exceed 4 or 5 miles in length. Most of these valleys carry water only after rains; but a few, such as the one that drains the vicinity of the Grand Falls, are filled with an abundant water. They rise outside the district, but in their courses across it receive important additions.

The general direction of the more important streams of the district east of the Kansas-Missouri State line, including the Kansas, and those east of the state line. The valley of Spring River, which flows southward and is divided by many small, shallow and open valleys. The direction of the major drainage lines, which are not numerous, and those that are found east and west of Neosho, are but gentle

The minor drainage lines have for the most part been determined by the physiographic factors commonly effective in such a region as this. The slopes are steep and the valleys are narrow; the streams are swift and deep. The streams have a general tendency to follow the strike of the rocks, unless they have been deflected by the structures of the underlying rocks, such as folds, or faults, or by the alignment of Shoshone Creek. The alignment of Shoshone Creek is simply coincidental. The minor drainage lines have for the most part been determined by the physiographic factors commonly effective in such a region as this.

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the limestone in this interval may be 100 feet or more of massive cherts, including the Grand Falls member and the cherts of the Lower horizon, together with the intervening beds.

The limestone of the Boone formation is a fasciculiferous granular crystalline rock which varies from fine-grained bluish limestone to light-gray, coarse-crystalline limestones or white marbles, as it is quarried in the Carthage district. The individual units range from sheets a few inches thick to massive beds 20 to 30 feet thick, with no indication of a parting on the weathered surface. These massive beds vary in the nature of the action of frost reaches to a depth of 5 feet and result in the exposed surfaces and cutting across the bedding planes. The massive beds are usually found to split up into smaller beds, perhaps with the intercalation of lenses and sheets of limestone along the bedding planes. The occurrence of stylolites, or "crowfeet," is common in these limestones.

The crystalline limestone of the Boone is nearly pure carbonate of lime and very similar in meteoric water, and in those rock under drainage systems and caves have existed in the past and are found at present. Quartzite in this part of the formation exhibit the usual number of cavities and enlarged joints filled with red clay and bellow of red clay and residual chert. The upper surface of the limestone is likewise covered with a mantle of red clay and residual chert. In many places where the formation at the surface originally consisted of thin-beded limestones the limestone has been carried away by solution, leaving the chert in broken and tafants and nearly pure limestone which encloses the red clay.

Distribution and thickness.—The Boone is 650 feet thick in certain places. The greatest thickness is 120 feet. The limestone and chert series overlying the Grand Falls limestone; it includes portions of the Osage, the Joplin, and the Hannibal series.

The chert varies considerably in physical character, both in different beds and in the same bed under different conditions such as above and below ground-water level. It is in general, when fresh, a light gray or in places to a depth of 3 feet and results in the exposed surfaces and cutting across the bedding planes. The massive beds are usually found to split up into smaller beds, perhaps with the intercalation of lenses and sheets of limestone along the bedding planes. The occurrence of stylolites, or "crowfeet," is common in these limestones.
oolite and consequently about 70 feet higher than the bed of Shoal Creek, which is made up almost wholly of heavy bedded chert.

The chert is not massive and heavy bedded, the surface being developed in thin beds and lenses, and locally even to a greater or less extent by solution. As all chert is slightly discolored in color, the brownish or yellowish tone which is characteristic of the Short Creek chert, making the total thickness 53 feet. The uppermost chert is fossiliferous at the top, where this formation is exposed as a rock floor. The chert underlies the flat bench adjacent to the Grand Falls, whereas some of the upper rapids of the Grand Falls are cut by tributaries of Shoal Creek.

The chert contains small, scattered, dark-colored, still almost alkali olivine olivines which are rounded, oval, or irregular in shape, some of the rounded units being half an inch or less in diameter. At points in the thick bedded chert of the Short Creek, the Grand Falls member rises in small outcrops to a thickness of 10 feet in a very small hill.

Here and there the chert contains small, scattered, dark-colored, still almost alkali olivine olivines which are rounded, oval, or irregular in shape, some of the rounded units being half an inch or less in diameter. At points in the thick bedded chert of the Short Creek, the Grand Falls member rises in small outcrops to a thickness of 10 feet in a very small hill.

Unlike the Grand Falls member, described from the thin bedded chert crops out 25 feet in thickness, but in the small creek flowing southward from Joplin, within the Carthage quarries, the chert is cut off by tributaries of Shoal Creek on the north side of the creek, and the Grand Falls member rises in small outcrops to a thickness of 10 feet in a very small hill.

The chert is next exposed in the vicinity of Turkey Creek, where it forms a bench or rock shelf 35 or 30 feet in height. Just west of the bridge the chert has been eroded and subjected to some tension, the axis, along which there has been considerable brecciation and recementation, bearing the name of “butcher-knife” flint. One of these flake occurrence bears N. 40°—50° W. and the other N. 50°—60° W.

A strongly marked system of jointing bearing N. 50°—60° W. cuts the rock at intervals of 1, 2, and 3 feet, and in these joint planes. It seems reasonably certain that the Grand Falls member of the Short Creek chert in the vicinity of Shoal Creek is a thin bedded chert, whereas some of the upper rapids of the Grand Falls are cut by tributaries of Shoal Creek.
of the species, as, for instance, *Caenograpthus arboreus*, are distinctly *Kooske*.  

**Shawnee Creek Oolite Member.**

Character.—The Shawnee Creek Member is a thin, but very persistent, layer of calcareous sandstone which is usually about one-twenty-fifth of an inch thick, but which may reach one-fourth of an inch in some places. The oolites are well-rounded and do not interfere with one another in the process of concentric growth. One of the most characteristic features of this member is the very coarsely crystalline character of the matrix. The oolites are also very commonly associated with thin bands of silt, which in places are so close together as to be indistinguishable. On a freshly broken surface the matrix gives a patchy reflection, and the spherules are large, up to one-twenty-fifth of an inch in diameter, or large and small mixed, having a white shell with a darker inner shell. Some of the more solid chunks are rounded and smoothed as if waterworn, and rolling to them is a disintegrated oolitic material which breaks easily. It is interesting to note the similarity between this oolite and the oolitic sandstone of the Late Cretaceous age, but it is not associated with fossiliferous rocks, and their proper reference is a difficult question. The great variety of shapes and sizes of the oolites, together with the fact that the majority are 4 to 12 inches long, make it impossible to establish a definite age for these deposits.

**Carterville Formation.**

Character.—The Carterville Formation occurs in many different parts of the state. It is a very heterogeneous and complex formation, consisting of a variety of rocks, including shale, light to dark argillaceous shale, arenaceous shale and sandstone, massive arenaceous sandstone, and conglomerate. In short, the whole category of oolitic rocks, with the exception of chert and quartz conglomerates. The limestone is in some places thinly bedded, but in others it is limy, and the lumps ranging in diameter from a few inches to several feet. These lumps occur embedded in oolitic or arenaceous rock, and their remolded shape seems due to water action, but to the circumstances of their deposition or consolidation. Where embedded in a calcareous matrix, the lumps are usuallv light-gray in color, and the spherules are large, up to one-twenty-fifth of an inch in diameter, or large and small mixed, having a white shell with a darker inner shell. Some of the more solid chunks are rounded and smoothed as if waterworn, and rolling to them is a disintegrated oolitic material which breaks easily. It is interesting to note the similarity between this oolite and the oolitic sandstone of the Late Cretaceous age, but it is not associated with fossiliferous rocks, and their proper reference is a difficult question. The great variety of shapes and sizes of the oolites, together with the fact that the majority are 4 to 12 inches long, make it impossible to establish a definite age for these deposits.
This page discusses the geologic formations and fossils found in the area north of the city of Carterville, Illinois. The text describes the presence of quartzitic deposits, oolitic limestone, shale, and sandstone, along with various fossils such as Pentremites sp., Fenestella ef. tenax, Trimbrachites sp., and others. The geological strata are mapped and described in detail, with sections labeled as A, B, C, etc., indicating different layers and formations.

The text also includes a table listing the species of fossils found at different locations, such as:

- *Pentremites sp.*
- *Fenestella ef. tenax.*
- *Trimbrachites sp.*

The table also notes the presence of various rock types, such as:

- Shale
- Sandstone
- Limestone

The geological formations are described as follows:

- **A list of the species is given herewith:**
  - *Pentremites sp.*
  - *Fenestella ef. tenax.*
  - *Trimbrachites sp.*

The text continues with a detailed description of the geological formations and their distribution, including the locations of shafts and cave-ins, and the stratigraphic relationships between different rock layers.

The overall focus of the text is to provide a comprehensive geologic map and description of the area north of Carterville, including the identification of different rock types and the fossil species found within them.
depressions in it. A series of large oucills occurs between Spring River and Center Creek and extends from Smithfield to Neck. South of Smithfield is a sandstone remnant, capped by a heavy bed of shale.

The Joplin formation is mostly sandstone, with more massive sandstone at the base. It is probable that these beds correspond to the two ridges of sand in the present drainage. It is important to note that the area north of the Joplin sandstone is a low-lying area, and the eastern part of the county is a high plateau.

The Joplin district is characterized by a series of Ou-Cliff and Oronogo: and a fourth north of Oronogo and west of Neck. Sandstone is found in the little knolls that dot these Ou-Cliffs, being somewhat more abundant in the western ones.

South of Center Creek there are several similar but smaller Ou-Cliffs—one 2 miles south of Webb Creek which has a length of 15 miles, another, just southeast of Webb Creek, and a third a little southwest of Locust. The remaining Ou-Cliffs of the area show the map largely consist of shale occupying depressions in the stream in places reaching to considerable depths. In these Ou-Cliffs the sandstone is generally eroded slightly lower than the general level of the country.

Relief.—Throughout the western interior coal field there is a stratigraphic break of erosional unconformity between the pre-Pennsylvania and the present erosion cycle. This break, where mapped, is generally a sandstone remnant a mile west of Lodi and on a line between Lodi and Oronogo, where more than 100 feet of shale is exposed. A shaft halfway between the hill and the Frisco Railroad shows 100 feet of shale. A shaft near the northeast at the southwest edge of the hill gives 115 feet of shale, but a quarter of a mile northeast of the hill and a half a mile southwest of a line from the center of the district, in a 200 miles southwest of this shaft the Boone lime is struck at a depth of 20 feet. The hill is 3 miles north of the Chippewa and extending through southwestern Ohio, the lower part of the hill is 2 miles west of two townships, is covered by the table, the table is the only logical conclusion.

Shale plates have already been described as occupying depressions in the Boone, thereby demonstrating the unconformity. The ore deposits on both sides of the river are of the same age, being either either subaqueous solution or to a subsidiary erosion. Most of the smaller, more massive Ou-Cliffs developed along Joplin and Galena sequences, the new channel of the stream will be filled with sand and gravel, and the new stream will appear.

A typical manifestation of the unconformity is seen at many places along the eastern limit of the Joplin formation where the hills on the west side of Spring River. Tongues of Conglomerate sandstone and sandstone extend out into the weathering valleys much below the normal level of the upper surface of the Boone tenure. Typical occurrence of this sort may be noted near the northwestern part of the district, where the excessive thickness of soil, from 10 to 50 feet, buries the gravel to a less extent over the high prairie in the southwestern part of the district, as well as over the deltaic deposits of the river in the area discussed in this section. The Cherokee was preoccupied, for Jenney, the origin of which is taken up under the heading "Structure." But some of the Ou-Cliffs are of the same character as the inselges and similar in thickness. This is due to the fact that the channel filled by the shale was not simple erosion channel, but had been subjected with the rest of the Ou-Cliffs to the influence of erosion, and the Ou-Cliffs were then to relatively great depths, analogous to the "lens "of modern river valleys, analogous to the "lens " of modern river valleys. A broken surface of the gravels are exposed under the soil in a bed varying from a few inches to several feet in thickness, but generally a few inches in diameter close to the coast.

The holding of the gravel has the usual characteristics of fluvial deposition. In the Joplin area these deposits are best developed along Spring River or within a few miles of it. They are well exposed all over the ridge lying between Spring River and Center Creek. There is a fine exposure 2 miles due west of Cre×, where a hill 3 miles north of it gives a thickness of 6 to 18 feet of banded gravel. This was the result of the fact that the shale was not in place, and the topography is such as can be interpreted only as the result of erosion of the softer shale layers.

The example of the gravel is seen at Pros×, near Spring River, where a hill 3 miles south of it gives a thickness of 6 to 18 feet of banded gravel. This was the result of the fact that the shale was not in place, and the topography is such as can be interpreted only as the result of erosion of the softer shale layers.

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residual blocks are in a measure finely shattered in Moreover, the binding material of residual cherts in the preceding section, show that the limit of than that. Their occurrence on this high point in the instance, cannot have originated at any nearer limestone areas can have been derived only from limestone areas closely the deposition of the lignitic Eocene of southeastern Missouri. The Lafayette gravels of the Timbered Hills, as well as the facts cited in the preceding section, show that the limit of modern overflow. It occupies the valleys of the larger streams and is not typical of the alluvial flood plains. The top of this section is likewise slightly above the curved margin of a quaquaversal dome formed by the simple tensional folds that cut the ore in places in the Ozark region are to be correlated with the long period of this epoch. Nearly all large springs in such a region emerge from some of these depressions, which may increase in size upward until the "cave spring" becomes a stream flowing from the mouth of a cave. Some of these, when a cavern collapses, as a result of enlargement beyond the self-supporting strength of the roof, or from any other cause, it is locally called a "natural cave," in contradistinction to the "cave-in" which occur when the roof of a mine fail. Such a cavern is called a "sink hole," closed valleys, and here and there through which enter streams draining considerable territory. When such a stream has its origin near by a large spring the depression is a closed val- classe of features which, from its typical development in the form of long, narrow, smoothly-walled valleys, has been called the pipe-like and channel-like features, which have been caused by the depression of a section of the roof of an under- ground passage. Among these features are sink holes, closed valleys, and where caverns are cut in the geologic past. The flow of water from the surface of the land and other causes, and have developed into closed valleys.

SOLUTION UNIQUENESS. At the time the post-Carrollville land was depressed beneath the Cherokee sea it exhibited a typical Karst topography of sink holes, caves, "lost rivers," closed valleys, and here and there valleys of surface erosion. The invasion of the sea, shale and sandstone filled the sink holes and valleys, and the finer sediments, seeking out the cave galleries, filtered and sifted through the revetments and passages until these too were made light to the surface. This is called a "karst topography," a hydrographic system of underground drainage which occurs in the limestone and chalk formations in the valleys of valleys, and around the limestone and sandstone cliffs and eroded surfaces of old river valleys and other causes, and have developed into closed valleys.

QUATERNARY DEPOSITS. The deposits of the Joplin area which may be referred to the Quaternary period are the soils, alluvium, and terrace deposits. The soils and terraces were largely developed during this period and are of some extent in connection with the Lafayette gravels.

The soils are in the region a thin deposit, but in the southeastern part of the district they reach surprising thicknesses. Numerous smaller deposits of alluvium are found, in which the upper plains are covered with 

residual blocks are in a measure finely shattered in Moreover, the binding material of residual cherts in the preceding section, show that the limit of than that. Their occurrence on this high point in the instance, cannot have originated at any nearer limestone areas can have been derived only from limestone areas closely the deposition of the lignitic Eocene of southeastern Missouri. The Lafayette gravels of the Timbered Hills, as well as the facts cited in the preceding section, show that the limit of modern overflow. It occupies the valleys of the larger streams and is not typical of the alluvial flood plains. The top of this section is likewise slightly above the curved margin of a quaquaversal dome formed by the simple tensional folds that cut the ore in places in the Ozark region are to be correlated with the long period of this epoch. Nearly all large springs in such a region emerge from some of these depressions, which may increase in size upward until the "cave spring" becomes a stream flowing from the mouth of a cave. Some of these, when a cavern collapses, as a result of enlargement beyond the self-supporting strength of the roof, or from any other cause, it is locally called a "natural cave," in contradistinction to the "cave-in" which occur when the roof of a mine fail. Such a cavern is called a "sink hole," closed valleys, and here and there through which enter streams draining considerable territory. When such a stream has its origin near by a large spring the depression is a closed val- classe of features which, from its typical development in the form of long, narrow, smoothly-walled valleys, has been called the pipe-like and channel-like features, which have been caused by the depression of a section of the roof of an under- ground passage. Among these features are sink holes, closed valleys, and where caverns are cut in the geologic past. The flow of water from the surface of the land and other causes, and have developed into closed valleys.

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The fact that so many of the caves and channels were filled at this time and later is due in part to the presence of the Grand Falls sheet. Another reason is found in the protection afforded the limestones by the Cherokee shale until that formation was filled in. Joplin is marked by valuable ore bodies, many of them lined with large crystals of calcite, and many outcrops of the Short Creek oolite and the Grand Falls chert, the intercalation of the sheet ground. These faults, when seen in cross section or for short horizontal distances, exhibit a regular gradation from the solid bed rock upward into the body of the shale, as noted in the locality. The breccia is shown in fig. 16 (illustration sheet). The breccia is a mass of angular blocks of shale and chert, the bedding remaining practically intact. The breccia is shown in fig. 16 (illustration sheet). The breccia is a mass of angular blocks of shale and chert, the bedding remaining practically intact. The breccia is shown in fig. 16 (illustration sheet). The breccia is a mass of angular blocks of shale and chert, the bedding remaining practically intact. The breccia is shown in fig. 16 (illustration sheet). The breccia is a mass of angular blocks of shale and chert, the bedding remaining practically intact. The breccia is shown in fig. 16 (illustration sheet). The breccia is a mass of angular blocks of shale and chert, the bedding remaining practically intact. The breccia is shown in fig. 16 (illustration sheet). The breccia is a mass of angular blocks of shale and chert, the bedding remaining practically intact. The breccia is shown in fig. 16 (illustration sheet). The breccia is a mass of angular blocks of shale and chert, the bedding remaining practically intact. The breccia is shown in fig. 16 (illustration sheet). The breccia is a mass of angular blocks of shale and chert, the bedding remaining practically intact. The breccia is shown in fig. 16 (illustration sheet). The breccia is a mass of angular blocks of shale and chert, the bedding remaining practically intact. The breccia is shown in fig. 16 (illustration sheet). The breccia is a mass of angular blocks of shale and chert, the bedding remaining practically intact. The breccia is shown in fig. 16 (illustration sheet). The breccia is a mass of angular blocks of shale and chert, the bedding remaining practically intact. The breccia is shown in fig. 16 (illustration sheet). The breccia is a mass of angular blocks of shale and chert, the bedding remaining practically intact. The breccia is shown in fig. 16 (illustration sheet).
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trolled solution originally. The broken chert resur-
face, from this brecciation, necessarily occupying more
space than in its original unbrecciated condition, would
be forced upward, displacing the deformed shales.
Then the next chert layer would be subject to
brecciation, the solution spreading upward and
forward and displacing the shale above.
Then the third stratum would be subject to breccia-
tion, and in time the fourth, and so on, the brecci-
ation progressing downward until the eroding
strength of the chert, added to the friction
encountered by the upward movement of the loose
material, would be finally counteracted by the normal
pressure on the bed of the fractures causing the
broken chert to sink in a downward direction. Simi-
larly, when the fractures of the chert are along the
plane of joints, the upper part of the breccia zone,
which was originally in the normal position as sheet
ground, would be forced upward, displacing the chert
layer. Consequently, the broken chert, in time, the
former, displaced by the latter, would be successively
forced upward, displacing the residual solution
originally in its position.
The broken chert, presumably at the joint which con-
trolled solution originally, the broken chert resur-
surface, from this brecciation, necessarily occupying
more space than in its original unbrecciated condition,
would be forced upward, displacing the deformed
shales.

Fig. 1—Cross sections of Chiselbar at "bar" in American Lead Zone, showing the presence of breccia at the base of the section and the position of the breccia contact with respect to the limestone and chert beds. Horizontal scale: 1 inch = 100 feet. Vertical scale: 1 inch = 25 feet.

The conjectured outline of the shale pocket is suggested.

Section A-D, 300 and 500 feet respectively from section A-A, the synclinal defor-
mation varies from about 10 feet in the former to
about 2 feet in the latter, accompanied in both
cases by fracturing, shearing, and some minor
brecciation. The broken chert at the bottom of the
section, the synclinal shape of the shale pocket,
and its upturned easterly dipping characteristics.
The broken and contorted shale, in the form of a
cliff or outcrop, is strongly suggestive of the
presence of syncline at the surface. The steeply
dipping cherts, the slickensides, the normal
crushed and brecciated chert. As in the other sec-
tions, the chert dips towards the center of the bar,
but away from the center of the bar the dip becomes
less until the dip is horizontal in the bar.

Fig. 7.—Missouri Pacific Railway cut at Carthage, Mo. The shale pocket is indicated by the vertical band of limestone. The shale, showing the synclinal character of the bar, the shale pocket, and divergent fracturing in the chert at the edges of the fold. Location of section lines is indicated on mine map B.

The conjectured outline of the shale pocket is suggested.

The conjectured outline of the shale pocket is suggested.

At the westernmost cross drift on the Homestead
tract, about 400 feet northwest of section D-D, the
dip of the shale is 20°-30° W., the dip dying out
northwest, and in the west drift on the Homestead
tract, about 450 feet northwest of section D-D, the
dip of the shale is 20°-30° W., the dip dying out
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such structural relations are those most favorable to
in the light of irregularities in the floor of the
mill, there are several "cave-ins" located in a roughly
elongated circle 400 feet wide and 600 feet long.
preceding paragraph it is necessary to suppose more
the yellow shale occurs are also readily intelligible
spreading apart of the walls of the cleft in which
seams occur farther east in the same cave-in, and
topsy-turvy. At the west end of the cave-in east of
extends down the contact as far as mined, about 50
study of the surface relations than any other known
Meek (Geol. Survey Missouri, Mo., a circle deposit, with brecciated central core and
Schmidt (Geol. Survey Missouri, 1855, pt. 1, p. 150; pt. 2, pp. 117-119), in describing
some rocks of which the central beds are of the same kind as the yellow shale of the
and during the preceding emergence, and those of the Carterville which were not pre-
whereas the surface was raised into a Kent topog-
lated by its effects, the post-Carterville erup-
tion was of much longer duration than the post-
emergence, and those of the Carterville which were not pre-
tected by their position in depressions were carried
at the same time the subsurface drain-
ance system was carried to a much higher degree of
development than during the preceding emergence,
and the surface was raised into a Kent topog-
Fig. 8—Section of wall of Gimlet cave-in, Jackson Hollow.
When the cave has been one of pure
lowed by Winslow, somewhat amplified to fit more
The shaft mentioned seems to be of this class. The thin shale
from that distance.
the master streams of surface drainage. Numerous
Pennsylvania sea to the northwest, the actual alti-
derived, but on the western border the Boone was
Cretaceous-Tertiary peneplanation.
the uplift, while problematical, certainly was exten-
tions were all filled up and the subterranean open-
ditions be generalized by omitting the recent
of the region be generalized by omitting the recent
of the Carterville imply complete submergence or
the post-Boone emergence, and those of the Carterville the land resumed the elevation it
had during the post-Boone emergence, and those of the Carterville which were not pre-
ected by their position in depressions were carried

**HEMATITIC DEPOSITS.**

The ore deposits. Meek (Geol. Survey Missouri,
Joplin. 1873-74, pp. 457, 452) attributes circles to the dis-
integration and solution of a circular mass of lime-
stone, possibly by underground solution, but his de-
pic is not to be understood, because it would be inadvisable to have
cave deposits at that depth below the present drainage.
the Boone formation was first member of the Mississippian to be
deposited, but on the western border the Boone was
preceded by the Costrom and the Hannibal, whose
the underground-water level approximately 200 feet
the Boone surface east of Spring River corresponds
in such fashion that the yellow shale of the Boone surface reached to that distance.
the Boone depression began to form, there were marine faunas at the surface which
correspond to those of the Pennsylvanian sea to the northeast, the actual alti-
tude above sea level was considerably less than at
Pennsylvania sea to the northwest, the actual alti-
the region shared in the general diastrophic
development than during the preceding emergence,
the post-Boone emergence was of much longer duration than the post-
the surface was wrought into a Karst topog-
the post-Boone emergence, and those of the Carterville the land resumed the elevation it
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Neosho. The elevation of the divide between Neosho and Spring rivers in this direction is about 800 ft. above tide. A description has already been given, under the heading "Other rocks," of the chief rocks forming the upland of the Ozark region nearly to its present elevation, which the rejuvenated streams have cut through. The rejuvenated streams attacked the peneplain with renewed energy, cutting canyons such as that of Shoal Creek, 150 to 200 ft. in depth, and widening the Ozark terrace from its earlier form to the greater part of the district, leaving only outliers standing here and there. At some time within this period the Neosho was established the new direct southerly course of Spring River below Baxter Springs.

The Lepidote Lahontan Limestone of the Lepidote Lahontan formation was reached in the early stages of the surveying and was described in the earlier reports. The present attitude of the surface of the district indicates that the surface of the district was nearly to its present elevation, which was established the new direct southerly course of Spring River below Baxter Springs. Post-Eocene (Lafayette) elevation.

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but the ore as marketed is in all cases impure, mainly from admixture with gossan materials.

**Chalcopyrite**—The two minerals of this group, chalcopyrite and chalcocite, are essentially the same, being simply different grades of the same mineral.

Chalcopyrite is one of the principal minerals of the Joplin lead-zinc district, and is also found in several others. The chalcopyrite of the district is of two varieties. One is a black or dark-brown variety, which is usually found in association with pyrite, and is known as pyrite-chalcopyrite. The other is a green or yellowish-green variety, which is usually found in association with galena, and is known as galena-chalcopyrite.

**Galena**—Galena is one of the principal minerals of the Joplin lead-zinc district, and is also found in several others. The galena of the district is of two varieties. One is a black or dark-brown variety, which is usually found in association with pyrite, and is known as pyrite-galena. The other is a green or yellowish-green variety, which is usually found in association with chalcopyrite, and is known as chalcopyrite-galena.

**Gypsum**—Gypsum is one of the principal minerals of the Joplin lead-zinc district, and is also found in several others. The gypsum of the district is of two varieties. One is a black or dark-brown variety, which is usually found in association with pyrite, and is known as pyrite-gypsum. The other is a green or yellowish-green variety, which is usually found in association with chalcopyrite, and is known as chalcopyrite-gypsum.

**Barite**—Barite is one of the principal minerals of the Joplin lead-zinc district, and is also found in several others. The barite of the district is of two varieties. One is a black or dark-brown variety, which is usually found in association with pyrite, and is known as pyrite-barite. The other is a green or yellowish-green variety, which is usually found in association with chalcopyrite, and is known as chalcopyrite-barite.
and 24), with many of the anhedrons elongated in the direction of the vertical axis. It is quite distinct from chert, the latter when unaltered having uniformly the microcrystalline and cryptocrystalline character of the angular fragments shown in fig. 27 (illustration sheet). Between the granules of quartz is a vitreous but everywhere small amount of bitumen in brownish films.

An aggregate of fine-granular allotriomorphic quartz, with sphalerite (shaded) smooth outline where adjacent to dolomite, but irregularly shaped grains through the rock and is massing of small included chert fragments near the bottom of the jasperoid, with only scattered crystals; and the well-defined forms of dolomite crystal aggregate where in contact with the jasperoid are all suggestive of such an explanation. Further study, however, has led the senior writer to an entirely different interpretation. His belief is that the jasperoid is, in nearly all cases, the result of a metamorphic replacement of limestone. It occurs locally in lenticular forms such as characterizes the occurrence of limestone in chert, and the manner of its occurrence in sheet ground suggests the replacement of sheets and lenses of limestone. More definite evidence is found in the fact that all stages in the increase in the proportion of quartz the limestone has been observed, both macerately and microscopically. These different stages are well shown in the Quaker mine at Chitwood. Coheribile facts are the occurrence here and there of fossils, particularly crinoids, in typical jasperoid, as well as the presence of sphalerite in a somewhat calcareous jasperoid at the Jack and Branch mine near Chitwood. This dark gray and in general appearance somewhat suggestive of limestone was observed.

Analyses of jasperoid

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<th></th>
<th>CO₂</th>
<th>SiO₂</th>
<th>Fe₂O₃</th>
<th>Al₂O₃</th>
<th>CaO</th>
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<td>11.50</td>
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<tr>
<td>Sample</td>
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<td>12.30</td>
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<tr>
<td>Sample</td>
<td>90.00</td>
<td>10.00</td>
<td>0.00</td>
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There has been considerable difference of opinion as to the origin of this rock. An explanation which naturally suggests itself at first sight is that it was originally of a soft, perhaps mudlike nature, having been altered later.

The dolomite grains have in few or no cases the medium- or dark-gray color which characterizes the rock as a whole, being usually pale gray with a pink tinge, which locally affects the rock mass. The common dark color of the rock is due to interstitial matter, ordinarily seen in the masses of small black or brownish cherts, but it also occurs as a rule a rough surface of oxidation products, on which the rhombohedral forms of many of the grains may often be seen.

Microscopically the texture of the dolomite approaches panaphanomorphic granular. The angular outlines of the crystals are by far the most common, followed by the occurrence of scattered crystals and anhe­drons, but the dolomite contains them to a very small extent.

It is invariably fine grained, and there resembles a fine-grained quartz in appearance. The more of the porous material, as seen with a lens, appears to be composed of pieces and fragments of quartz crystals. The dolomite is in pieces, though not commonly, banded, its mode of occurrence is not unlike that of the jasperoid, but it has nowhere been noted in large amounts, especially as cement to cement breccia.

The general process of replacement, as shown by the dominant jasperoid, is, as is well known, a fine-grained, and here and there resembles a fine-grained rock; the fine-grained crystals of igneous rocks. (See fig. 26, illustration sheet.)

The general occurrence of selvage is not unlike that of the ore body, the limestone which was originally in these dolomites. As already noted, jasper­oid in the Grand Falls chert along Shoal Creek, and along Shoal Creek between Galena and Empires. It is invariably more or less weathered, and its borders are usually ragged and clearly defined. The "fences" of barren ground against which the ore has formed. These "fences" have a vertical extent corresponding to that of the ore body, and range from several hundred feet to perhaps 800, or where they occur between two parallel ore bodies, to as much as 140 feet. Dolomite is found most commonly interbedded with cherts, but it also occurs as the cement of chert breccia.
jasperoid may contain fresh, unaltered crystals of calcite, greyish-white or blackish in color, and in the vicinity of the ore deposits. Calcite occurs as a cement to breccias it is in many open or bowldery ground, large slabs of chert are common in these breccias, dipping usually in a northerly direction. All the more important areas that are due to the recrystallization of original limestone. The alteration of chert is the result of a dislocation due in most cases to the recrystallization of original limestone; hence the miners cannot work in them for more than five or ten minutes at a time. In one of the deposits of the Cheltenham mine, east of Joplin, the temperatures in the drifts rise to 150 feet.

The greatest dimension of the runs is horizontal, the other important rocks of the ore deposits are chert breccia, in both of which the jasperoid is the production of selvage, and the final stage results in the black mud so commonly seen on the ores. The greatest number of runs is horizontal, the other important rocks of the ore deposits are chert breccia, in both of which the jasperoid is the production of selvage, and the final stage results in the black mud so commonly seen on the ores.

Joplin.

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occur both east and west of Joplin, being especially numerous on the Missouri and Zinc Company's land, where they form one of the principal types of deposit. Fine examples occur also in the valley between Carl Junction and Lehigh on the southern part of the Center Creek Mining Company's land and on the northern part of the Missouri Zinc Company's land (mine map E).

The circles very greatly in size. The smallest one noted that forming the 30-36 foot level northwest of the Gretchin shaft (No. 96, mine map F), on the Missouri Lead and Zinc Company's land, is about 100 feet in diameter. The largest diameter of this circle is 1100 feet. The largest circle mapped is one with an elliptical form on the northern portion of the New York Zinc Company's land (see mine map D), near Carterville, the longest axis of which is about 2000 feet and the shortest about 1600 feet.

It is clear that these large-scale relations that have been described for the simple runs likewise prevail in the drill deposits, though, owing to their nature, perhaps to a less extent. The rock bodies are not as a rule equally developed through their entire extent, neither is the total circular area. In the northern and southern parts of the New York Zinc Company's land, circles of about 1000 feet in diameter are present, while in the southeastern part of the company's land, circles of about 500 feet in diameter occur. The thickness of the ore body is not as a rule equally developed through the entire extent of the circle, either horizontally or vertically. The ore body is usually thin and discontinuous near the margins of the circle, but may increase in thickness toward the center of the circle. The ore body is usually thickest near the center of the circle and thickest near the margins of the circle, but may increase in thickness toward the center of the circle.

The horizons of the sheet ground, unlike those of the simple run, appear to be well defined. Small deposits of this character occur in association with veins, at various horizons throughout the photographic formation, and in particular just above the Grand Falls shaft, but the typical sheet ground has been developed invariably in the Grand Falls shaft. The sheet ground, as a rule, is first, requiring the presence of a large deposit of brecciated zone and the associated ore deposit, varying more or less in different parts of the circle. The central zone of the ore deposit is usually limited to a cylindrical area around the shafts, where the ore body is thickest. The ore body is usually thickest near the center of the circle and thinnest near the margins of the circle, but may increase in thickness toward the center of the circle.

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lie in the basin or on the slopes, or cross over the crests of anticlines with equal indifference. The controlling factor of the location of the ore deposits has been the existence of breccia.

**Chemical and Physical**

**Relation of ores to shale patches.** - Aside from the local and indistinct relation of the shale to the ore deposits in the area due to their common relation to the geologic structure, the shale may also exercise a positive precipitating effect on the ore solutions. In many deposits the ore "makes against the shale." This localization may be accomplished in several possible ways:

1. The shale, being relatively impervious, acts as a barrier to intercept the circulation of the ore solutions, with consequent mingling of the waters of various tracts channels and resulting precipitation.
2. The shale, being relatively rich in ferromagnesian organic matter, precipitates the metals by reduction of the sulfates in solution.
3. As shown by Sullivan's experiments (Economic Geology, vol. 1, 1905, p. 60) on the precipitation by shale of copper from solution of the sulfates, the shale may act directly as a precipitant by exchange of bases.
4. Finally, the shale may act as diagraphy, with resulting concentration of certain solutions at the surface of the shale, as suggested by Becker (Mineral Resources U. S. for 1892, p. 156), a disturbance of the normal balance of the solution which may result in precipitation of the ores.

**Relation of ores to ground.** - Galena and sphalerite become common in close and often well-understood differences in habit in their presence for breccias of different ages in the numerous quartz-flint conglomerates. For instance, in the exposed, more open breccias it is a rule largely sphalerite, with very little galena. On the other hand, where the breccias are fine textured and open the proportion of galena is much larger. Where the amount of galena is very small and the demineralized ore is sphalerite with practically no galena, whereas where the sphalerite is more abundant and the quartz-flint material forms the cementing matrix, galena is more prominent, being locally in excess of the sphalerite. Again, in many places sphalerite seems to be confined to the massive dolomite adjacent to the exclusion of galena, even in the finer breccias, while galena is apparently abundant on the margins of the ore body away from the dolomitic.

**Vertical relations.**

**Vertical distribution of the ores.** - Aside from the effects of oxidation, the most noticeable feature of the vertical distribution of the ores is the frequency of observed abundance of galena in the upper parts of the deposits, with little ore in the lower levels. This point has been emphasized by both Van Hise and Rain. On the other hand, there is a general increase in value with depth in the mining tracts, descriptions of which are subjoined.

Above the sheet ground the occurrence of ore is limited to certain ore horizons separated by barren ground, while below the sheet ground the deposits have a shape that can be described as scalloped. This vertical order is shown in the drill holes, both ores are found to a depth of at least 400 feet. It is remarkable that almost all the deposits have a shelf of some sort that is barren of ore. The occurrence of these barren shelves is shown by drill holes, but how it came about is not known.

The general increase or decrease in value with depth is shown by the Hegoda mine (No. 95, mine map E), which occurred in chert breccia adjacent to the dolomite. Oxidation has taken place and which have never, whereas where calcite forms the cementing matrix, not been affected by oxidation. The presence of clinal structure of the shale patch is well shown in the maps of some of the more important mining tracts, descriptions of which are subjoined.

The ore bodies are largely in well-defined connected masses of shale is shown to be exceptionally close. The boundaries of the area shown on the map, though not well defined, are, for the most part, a single horizon with a vertical range of several ore horizons separated by barren ground, or only a single horizon with a vertical range of several feet. Of the possible ore deposits below the Grand Falls chart comparatively little is known, the data being derived entirely from a few widely centered drill holes. Of the several thousand drill holes which have been put down in the district a large proportion are shallow, limited approximately by the present depth of mining in their vicinity. Some of them are below the Grand Falls chart but which have never, whereas where calcite forms the cementing matrix, not been affected by oxidation. The presence of clinal structure of the shale patch is well shown in the maps of some of the more important mining tracts, descriptions of which are subjoined.

Relations similar to those just noted may be seen in mine map F. The association of ore deposits with the valley is close in the whole, though several of them occur beneath horizons between the valley and the deposit. The deposits are found chiefly in two main areas, both with a general northerly trend. These two principal zones, following branches of Joplin Creek, unite at the Summit Hill and are relatively small amount of both marcasite and pyrite in the Boone formation has already been noted. In the drill cuttings from the Freeman coal mine in Joplin iron sulfide is shown in small amounts of minute or microscopic crystals, and grates at many horizons in the Cherokee shale, both being locally abundant in these runs. In view of the relative interdependence of these structures to circulating waters and their general freedom from land and zinc sulfides, the concentration of iron sulfides in these is perhaps to be explained on the ground that the iron was not brought from a distance, but derived from the shale themselves. The relatively small amount of both marcasite and pyrite in the Boone formation has already been noted. In the drill cuttings from the Freeman coal mine in Joplin iron sulfide is shown in small amounts of minute or microscopic crystals, and grates at many horizons in the Cherokee shale, both being locally abundant in these runs. In view of the relative interdependence of these structures to circulating waters and their general freedom from land and zinc sulfides, the concentration of iron sulfides in these is perhaps to be explained on the ground that the iron was not brought from a distance, but derived from the shale themselves. The relatively small amount of both marcasite and pyrite in the Boone formation has already been noted. In the drill cuttings from the Freeman coal mine in Joplin iron sulfide is shown in small amounts of minute or microscopic crystals, and grates at many horizons in the Cherokee shale, both being locally abundant in these runs. In view of the relative interdependence of these structures to circulating waters and their general freedom from land and zinc sulfides, the concentration of iron sulfides in these is perhaps to be explained on the ground that the iron was not brought from a distance, but derived from the shale themselves. The relatively small amount of both marcasite and pyrite in the Boone formation has already been noted. In the drill cuttings from the Freeman coal mine in Joplin iron sulfide is shown in small amounts of minute or microscopic crystals, and grates at many horizons in the Cherokee shale, both being locally abundant in these runs. In view of the relative interdependence of these structures to circulating waters and their general freedom from land and zinc sulfides, the concentration of iron sulfides in these is perhaps to be explained on the ground that the iron was not brought from a distance, but derived from the shale themselves. The relatively small amount of both marcasite and pyrite in the Boone formation has already been noted.
shown in the southeast half consisting chiefly of sheet ground, and those in the northwest half almost wholly of range. The minor relief, to be noted in the range are the general limitation of the mine to the valley and the commonly close association of the one with the occurrence of slate at the surface. The zone in the northern part of the area mapped by the general northeasterly trend. The main structural lines, as seen in the arrangement of the ore body, are both northeasterly and northerly, but the latter being apparently dominant. As in most of the mining areas already considered, the ore zone is a whole a general northwesterly trend, aside from which no definite groups are to be found, in their present stage of development, to show any definite grouping, though some of the ore bodies have a general elongation parallel to the local minor surface features.

The relation of the sheet ground to topography and to the occurrence of surface slate is substantial to that seen in area is well-exemplified from this map. The ore zone, as a whole, a general northwesterly trend, aside from which no definite groups are to be found, in their present stage of development, to show any definite grouping, though some of the ore bodies have a general elongation parallel to the local minor surface features.

The relation of the sheet ground to topography and to the occurrence of surface slate is substantial to that seen in area is well-exemplified from this map. The ore zone, as a whole, a general northwesterly trend, aside from which no definite groups are to be found, in their present stage of development, to show any definite grouping, though some of the ore bodies have a general elongation parallel to the local minor surface features.
as already mentioned, occurs abundantly as pseudo-
original mineral. In other cases the products of
in the rock until the whole is replaced.

... of smithsonite from the Ozark region show
is its in general vertical rather than lateral,
unchanged that channel that has been
leaked by the waters that deposited the sulphides
of oxidizing solutions. No instance has
in which the solution of oxidized ores have
2.59 per cent of lime. Zinc carbonate
of silicic acid, resulting in the formation of a
for sulphur. Lead, since it has the
the oxidation of the ores of first
mercially true for the district as a whole, although
ore in which the ore of first concentration
amount just below water level may be
in the process of oxidation tend to migrate, being
lead is free from nodules and lentils of chert, it
in all parts of the district, though at present there
is no fine stone from nodules and lenses of chert, it
hand worked before burning. The value of the
from the Boone formation, and as none of this
are but three kilns in operation, one in the northern
stones are the hills another runs out, and this,
never been stripped all along Steeple Creek and its
the northern edge of the district are several banks
which have been extensively stripped, yielding in all
a mill east of Lakeville, is widely known to
the limestone. At this point the limestone is a
at a depth of less than 20 feet, it will be concentrated.

Coal is obtained by mining or strip mining at a
to an elevation of 1000 feet above sea level. This
the southern edge of the district are four limestones
... and claystone beds, which are in many places
of the limestone, more or less free from chert, are
more than 98 per cent of lime. Lime produced
produced annually is from $5,000 to $8,000.
kes in operation, one in the northeastern
the district as a whole, and in the northern

the quarrymen. Ordinarily they are not deep,
the limestone has a crushing strength of over 12,000 pounds to the

Stone is quarried in a small way from the
in this district. The lower two of these sandstone beds, the
tendency to break up into flakey layers, and this is the one most
The Plains Valley quarry, located near
in the center of the NE 1, SE 3, T. 33 S., R. 25 E.,
21/2 miles south of Crealine, is the largest.

in the limestone, though locally scattered through the body of the
are in the ores of first concentration, generally
amount of enrichment that could be presumed in the
time of the ores of first concentration, by
result of a second period of concentration by
amount of this enrichment, so far as it could be
in the first concentration. Not all of the lead
is the sulphide, by reaction with marcasite.
in the ores of first concentration by
of the said district, which have just been described, the recog-
the ores within the belt of weathering. Zinc sulphate, taken into solution by underground waters,
reducible by the ascending waters. In the case of the mines of the
are generally true for the district as a whole, although
are few ore bodies in which the ore of first concentration forms an important part
of the ores of first concentration by
the ascending waters. No instance has been
in which the solution of oxidized ores have

following are furnished in this way, as a secondary con-
which is encountered in the limestone. At this point the limestone is a
at a depth of less than 20 feet, it will be concentrated.

Confirmation of this view is seen in the films of
the oxidation of the ores of first concentration by
amount of this enrichment, so far as it could be
in the first concentration. Not all of the lead
is the sulphide, by reaction with marcasite.
in the ores of first concentration by
the ascending waters. No instance has been
in which the solution of oxidized ores have

the limestone has a crushing strength of over 12,000 pounds to the
and limestone, in places upon "cement plates," by which it is also overlain. Another pocket just west of the milltown on the south side of sec. 19, T. 29 N., R. 30 W., was circular, 300 feet in diameter and 6 feet in depth near the center. Another occurred 2 miles south of Ozark Junction, a shale patch yielded coal from 3 to 4 feet thick. In the shale strip passing through Neosho, just west of the road leading south of town, is a deposit of coal ranging from 5 to 9 feet in thickness in the middle of the strip, rising and thinning out toward the sides of the mine in less circular form. On the best exposure to the west a similar pocket exists, the coal ranging from 23 to 8 feet in thickness. South of Carterville, on the Homestead Company's ground, coal 6 feet thick was struck; and just south of this point, in the town of Carterville, upon some property of Lake County Zinc Field land, two small pockets of coal of a maximum thickness of 6 feet were mined until exhausted. Other similar coal pockets occur over the district, but those mentioned are the most important.

CLAY.

The clays of the district are of three varieties—residual clay, alluvial clay, and shale. Residual clays are the red clays resulting from the decomposition and disintegration of the limestone and of the chert of the region. They crop out in every gully and wash, but are not of economic value. Alluvial clays are made up of transported residual clay mixed with a variety of foreign material, chiefly sand. They abound along the valleys of all the streams and are suitable for the manufacture of building stone and brick. The alluvial clays in the region under the Cherokee formation have been and are still being mined and are used extensively for cement. The shale clays are limited to the areas of the basins which have been referred to the Lafayette and the Boone rocks. Wherever the surface gravels and sands which have been referred to the Lafayette, the soils and gravel over the remainder of the district are macadamized, chiefly with crushed limestone and chert of the Boone formation. The shale clays are of economic value in the manufacture of artificial building stone and brick.

ROAD MATERIAL.

The main roads leading from the principal towns of the district are macadamized, chiefly with crushed limestone and chert of the Boone formation. The shallow gravel of the stream beds and the fillings from the hollows have also been used where available, both making very good macadam. The upland gravel gravels have been used to a very limited extent, only where the roadway happened to cut through a deposit. The heavy beds of gravel, 15 to 20 feet thick, which have been already described as occurring on the upland west of Carthage and in the vicinity of Spring River, offer abundant road material of the best quality. A top dressing of clays is often used and forms an excellent binding material.

SOILS.

The upland soils of the Joplin district are for the most part thin, ranging from a few inches to several feet in depth, though on the high plains in the southeastern portion they may attain a maximum thickness, containing a thickness of 25 to 60 feet. In the region under the Cherokee formation their thickness is very great, the surface being raised above the bottom of the valley and the soil extending over the entire area underlain by the Boone sands. Wherever the surface gravels and sands which have been referred to the Lafayette were deposited, they have sided materially in the formation of the soils, particularly of the transported alluvial soils of the stream valleys. Over the area underlain by the Boone the soils and gravels usually rest upon bedded residual clay with red clay partings. Where the soil is thin these partings are exposed in every little wash, and upon the surface is shown with loose fragments of chert. The alluvial soils of the district are the most fertile, the upland prairie soils somewhat less so, and the soils of the hilly country least fertile of all.

WATER RESOURCES.

Springs.

Spring River has an average fall through the district of 3.6 feet to the mile, though locally the fall is considerably greater. The average fall of Center Creek is 63 feet per mile. At the Grand Falls of Shaw Creek, 24 feet of land is supplied by the Southwest Missouri Electric Light and Power Company. Just below the diversion of Shaw Creek by this power company, Grand River at Lowell, the new concrete dam of the Spring River Power Company gives a head of 24 feet. At many other places on Shoal Creek, Grand River, and Spring River smaller heads of water are utilized by small mills.

Mineral water source.

Carthage is furnished with water from Spring River, the intake being located just north of the city. Wolfe City draws its supply from Cisser Creek at a point a mile above Ozark. Joplin and Galena are supplied from Shoal Creek, the pumping plants being almost due south of the respective cities. Empire gets water from a deep well put down by the town for that purpose. Baxter Springs is furnished with water from a well which draws its supply from the Grand Falls chert. Logano, on the city of White City, Joplin, and Galena, the water from deep wells, so as many of the larger mining camps, which are forced to do so to obtain suitable boiler water. As the springs are cut through by the creek, offering excellent chances for the intake of water. June, 1904. Revised June, 1914.