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Geology of a carboniferous outlier in Lawrence County, Missouri

Maurice Merton Albertson

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GEOLGY OF A CARBONIFEROUS OUTLIER
IN LAWRENCE COUNTY, MISSOURI

by

M. Albertson

A
THESIS
submitted to the faculty of the
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DEGREE OF
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1911.

Approved by

Assistant Professor of Geology and Mineralogy
GEOLOGY OF A CARBONIFEROUS OUTLIER

IN LAWRENCE COUNTY, MISSOURI.
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Limestone cave in sec.8, T.26 N., R.25 W. -- 15
LOCATION

In this discussion will be included sections 27, 28, 32 and 33, T.27 N., R.25 W. and sections 4, 5, 6, 9, 16 and 17, T.26 N., R.25 W. This area of 10-12 square miles lies in Lawrence county, Missouri, between the towns of Aurora and Marionville. Marionville has a population of about 1300, and is supported largely by the farming and fruit growing carried on in its vicinity. Aurora has a population of about 5000 and, in contrast with Marionville, is supported very largely by mining, lead and zinc mines being just east of the city. Both towns are surrounded by a fairly level country in which farming is the business of chief importance.

TRANSPORTATION

The towns of Aurora and Marionville are located on the main line of the St. Louis and San Francisco Railroad and are about five miles apart. In addition to the "Frisco", Aurora has a branch line extending to the north and is also located on the White River division of the Missouri Pacific Railroad. The wagon roads leading into Aurora are macadamized for a distance of about five miles.
FIELD METHODS

Part of the field work upon which this report is based was done while mapping for the Missouri Bureau of Geology and Mines during the summer of 1910. The work was completed during the latter part of December of the same year, and the early part of January, 1911. Before beginning mapping for the Missouri Bureau of Geology and Mines, several days were spent at Pierce City, Carthage and Webb City, in studying the formations likely to be found in the area to be mapped. At Pierce City the Boone formation is quarried for the manufacture of lime and excellent exposures have been made. At Carthage the Cherokee formation is exposed along the Frisco railroad, while near Webb City caved-in mine workings expose the Carterville formation so that it may be studied to good advantage.

As a base map, the topography of the "Aurora Special" quadrangle was used. The scale on which this map is constructed is 1 in. to 48000 in. A Gurley's geologist compass was used; outcrops were located by pacing when necessary.
PHYSIOGRAPHY

SURFACE RELIEF

The area is one of low relief. The point of greatest elevation is not more than 1400 feet above sea level; it occurs in sec. 4, T.26 N., R.25 W., and is nearly in the center of an area which is known locally as the Sand Ridge because of the nature of the underlying formation. The point of lowest elevation is not less than 1300 feet above sea level and occurs in the extreme northeast part of the area. As a whole the area is quite flat, and nowhere, except in the extreme northeast part, are there any abrupt changes in elevation.

DRAINAGE.

Honey Creek crossing sec. 24, T.27 N., R.25 W. is the only perennial stream in the area. In section 32 of the same range and township, there is a small stream fed by springs which flow during a part of the year, and two small streams head in sec. 5, T.26 N., R.25 W. One of these flows almost directly west for a mile or more where it turns to the northwest, and is known as Reed's Branch;
CROSS SECTION TO ACCOMPANY MAP

LEGEND

- Boone Formation (Mississippian)
- Carthage Formation (Pennsylvanian)
- Cherokee Formation (Pennsylvanian)
- Chart (Probable Mississippian)
while the other starts almost due north, turns to the northwest within a mile or so and is known as Elm Branch. Chat Creek flowing through the center of Aurora is a stream similar in size and character to the last two mentioned. All of these streams, with the exception of Honey Creek, are usually dry during a part of the year unless the water pumped from the mines is sufficient to keep them running.

**GEOLOGY**

**STRATIGRAPHY**

The formations which occur over this part of the State belong to the Carboniferous system, representatives of both the Mississippian and the Pennsylvanian periods being present. To the former belongs the Boone limestone and to the latter the Carterville and Cherokee formations. A general section of these formations from the base upward is given below.
<table>
<thead>
<tr>
<th>System</th>
<th>Formation</th>
<th>Columnar Section</th>
<th>Thickness (feet)</th>
<th>Character of Formation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carboniferous</td>
<td>Cherokee</td>
<td></td>
<td>1000</td>
<td>Red, brown, and black shale interbedded with red and redish-yellow sandstone.</td>
</tr>
<tr>
<td></td>
<td>Unconformity</td>
<td></td>
<td>0-50</td>
<td>Dark shale,oolitic limestone and a fairly fine grained fossiliferous sandstone.</td>
</tr>
<tr>
<td></td>
<td>Cartforville</td>
<td></td>
<td></td>
<td>An exceptionally pure limestone with interbedded chert. The limestone varies from coarsely crystalline at the top to finely crystalline in depth.</td>
</tr>
<tr>
<td></td>
<td>Boone</td>
<td></td>
<td>400-480</td>
<td></td>
</tr>
</tbody>
</table>

**BOONE FORMATION (Mississippian Period)**

This formation is also known as the Burlington*, and Dr. Girty of the U.S. Geological Survey classes it as Keokuk**. It is widely distributed over Missouri.

---

in the southwest corner of which it is the youngest formation which is continuously present. At numerous points occur irregular patches of sandstone, shale and some limestone, which overly the Boone limestone, but these are commonly of small area and slight thickness. The outlier which is the subject of this discussion is one of the few exceptions.

The Boone is commonly covered by residual clay and chert varying from 20 to 60 feet in thickness so that it is only along the more important streams that outcrops are found. The formation has a maximum thickness of about 480 feet. It is grayish white in color, very fossiliferous, coarsely crystalline in the upper part, and finely crystalline in the lower beds. It is easily recognized by the character of the fossils, the most common of which is probably the crinoid stem, although brachiopods, corals, and the heads of crinoids are also quite common. It is a heavy bedded formation, styolitic joints being common and rarely more than two feet apart. In composition the formation is a very pure limestone containing a considerable but variable amount of inter-bedded and nodular chert.
The limestone is extensively quarried for building purposes at Cartmage. It might be expected that the stylolitic joints would be planes of weakness, but they do not appear to have any serious effect on the strength of the stone, even when it is used for important building columns. As the stone occurs at Cartmage, it is exceptionally free from chert, and there is not a better building stone, or a more handsome one, to be had within the central Mississippi Valley. The stone is also quarried at numerous points for the manufacture of lime, which, because of the purity of the stone, is of a very high grade.

CARTERVILLE FORMATION (Pennsylvanian Series)

The Pennsylvanian series is represented by two formations, the Carterville and the Cherokee, which for the most part are present as small irregular deposits.

The manner of occurrence of the former is one of the most interesting geologic features of the Aurora mining area. So far as known, it extends over only a very small area, being limited to a narrow strip reach-
ing west from Sand Ridge, in sec.7 and 8, T.26 N.,
R.27 W. Mr.W.H.Scott of Aurora states that there are
two of these strips. He describes them as being paral-
lel and also says that they deepen as Sand Ridge is
approached and continue under it. These opinions of
Mr.Scott's were unknown until after the field work had
been practically completed. The Carterville formation
had been noticed to deepen as Sand Ridge was approached,
and it was also known to exist at one point some distance
to the east of the western edge of the sandstone area,
but no evidence of the existence of a second strip was
observed. Owing to lack of time and the difficulty of
securing records of drilling, no attempt was made to map
this second area, but it is believed that a large part
of Sand Ridge is underlain with the Carterville formation.

The formation consists of a drab to black colored
slate, an impure oolitic limestone, and a fine grained
sandstone. The total thickness is not accurately known
for this area, but in the Joplin district the reports
of the U.S.Geological Survey show the thickness to vary
from 0 to 50 feet, and this is believed to hold in the
vicinity of Aurora.
The limestone where fresh and unoxidized is of a gray-white, but when oxidized it is of a dirty red color. Numerous small crystals of pyrite were noticed on all the dumps showing Carterville. The oolite grains are neither uniform in size nor regular in shape, varying from round to flat and elongated forms. Mixed with the oolite grains are numerous fossils, many of which occur also in the shale. In the sandstone but few fossils were found, and these were very poorly preserved.

Relations:—Other geologists who have examined this area accounted for the presence of Carterville formation by faulting, but the great length of the known Carterville area as compared to its width makes this appear very improbable and is good reason for believing an unconformity to be present. The reasons for believing the peculiar occurrence of the Carterville is due to an unconformity rather than to faulting are as follows:

1. The Carterville consists of a narrow curved band, and would require two curved, parallel faults to account for it.

2. The depth of the Carterville increases as Sand Ridge is approached.
Plate I.

(a) Dipping of Sandstone Beds, Mo. Pac. R.R. Cut.

(b) Small Fold, Mo. Pac. R.R. Cut.
3. The relation of the Carterville area to that of the Cherokee sandstone makes it seem very probable that they are due to similar causes, and there is much evidence to show that the Cherokee sandstone lies in an old stream valley.

4. Elsewhere the Carterville and Boone formations are separated by formations which are here absent. It is believed by the writer that the Carterville lies in the channel of an old stream which emptied into a larger one, the valley of which is now filled by Cherokee sandstone and shale, together with some underlying Carterville.

**CHEROKEE FORMATION**

That part of the Carboniferous outlier mapped consists chiefly of sandstone, although at some points there are considerable amounts of shale. The sandstone area is not covered with timber and, where the grass or other vegetation is not unusually dense, the contact between the sandstone and the limestone may be quite easily followed by means of the nature of the soil and the character of the rock scattered over the surface. Much of the surface is covered by residual sandstone boulders, and
Plate II.

(a) Cross Bedding, Mo. Pac. R.R. Cut.

(b) Weathered Sandstone, Mo. Pac. R.R. Cut.
Plate III.

(a) Weathered Sandstone, The Pac. R.R. Cut

(b) Interbedded Sandstone and Shale, Mile R.R. Railroad Cut
where the sandstone is not the underlying strata the surface is generally covered with pieces of chert which have resulted from the removal of the Boone limestone. As shown by old wells, shafts, and stream channels, the sandstone is as a rule found within five feet of the surface. Along the eastern edge of Sand Ridge in sections 4 and 9, the sandy soil continues for some distance farther east than does the sandstone stratum. Perhaps this may be explained by the direction of the slope in this locality; while it is also possible that the sandstone at one time extended farther to the east. In this connection note the east-west section A-B.

Texture: In texture the sandstone varies from fine to very coarse. The sand is quartz, and the larger grains are well rounded while the smaller ones are but slightly so. There is a large amount of conglomerate, especially along the western contact and along the southern end. The conglomerate of the former contains but a small amount of sand, most of the formation being made up of hard, well rounded pieces of chert varying in size from two to six inches in diameter. The greatest thickness of conglomerate exposed is about 20 feet, and mine occurs at the caved-in workings in the N.W.1/4 sec.8,
T.26 N., R.25 W., where it is in almost direct contact with a perpendicular face of Boone limestone. A conglomerate of different character is found at the southern end of the sandstone area. The pebbles are of similar material, but they are smaller in size, better rounded, and do not form such a large part of rock mass. A few pebbles of quartz, and also a few of hard, fine-grained, silicious oolite were seen in the Missouri Pacific Railroad cut near the southern end of the sandstone. So far as known, no similar material is found in place within 50 miles, nor has any similar material been found at any other point on the Aurora quadrangle so far as known. In hardness the sandstone varies from soft and crumbling to a hard quartzite. The color of the rock is generally light yellow, though it varies from deep red to white and at one locality it was noticed to have a greenish shade.

**Weathering:** Under natural conditions of exposure the sandstone seems to resist weathering somewhat better than the Boone limestone. This may be due to the hardening of the outer part so as to form a sort of crust which protects the underlying portions. However, when this crust is removed by some artificial means, and the fresh sandstone exposed to weathering action,
it crumbles very rapidly. In the Missouri Pacific Railroad cut the sandstone has crumbled away to the extent of several inches during the five years which the cut has been in existence. The relative thickness of soil covering the two formations, as well as the topographic position of the sandstone area, may be explained as being due to its greater resistance. The highest point within the area mapped occurs in section 4, at about the center of the sandstone formation.

Structure:—Owing to the nature of the topography the structure is necessarily obtained from the drilling which has been done, and from such artificial exposures as have been made. The Missouri Pacific Railroad cut crosses the southern end of Sand Ridge and it is here that the structure of the upper part of the sandstone is best studied. Referring to the photographs it is seen that the formation varies from well bedded, horizontal layers to a mass of boulders with little or no trace of bedding. The cut shows several small folds similar to the one photographed, and local dips of 5 to 10° are common. Cross-bedding is shown in one of the photographs. The sandstone has numerous joints or cracks, some of which are as much as four or five inches wide and are filled with sand and clay.
A cross-section of the sandstone and underlying formations at about the north line of section 8 is shown in the drawing. This section is made up almost entirely from information obtained from Mr. W.H. Scott.

In thickness the Cherokee varies from 0 to 130+ feet in this locality. Drill holes put down in sections 5 and 8 show formations which are well indicated by the following section:

<table>
<thead>
<tr>
<th>Layer</th>
<th>Feet</th>
</tr>
</thead>
<tbody>
<tr>
<td>13 Clay</td>
<td>2</td>
</tr>
<tr>
<td>12 Sandstone</td>
<td>95</td>
</tr>
<tr>
<td>11 Yellow chert</td>
<td>43</td>
</tr>
<tr>
<td>10 White chert</td>
<td>4</td>
</tr>
<tr>
<td>9 Yellow chert</td>
<td>65</td>
</tr>
<tr>
<td>8 Chert &amp; slimes of galena</td>
<td>6</td>
</tr>
<tr>
<td>7 White chert</td>
<td>13</td>
</tr>
<tr>
<td>6 Dark chert</td>
<td>10</td>
</tr>
<tr>
<td>5 Light chert &amp; limestone</td>
<td>30</td>
</tr>
<tr>
<td>4 White chert</td>
<td>10</td>
</tr>
<tr>
<td>3 Light chert &amp; limestone</td>
<td>3</td>
</tr>
<tr>
<td>2 Calcite</td>
<td>20</td>
</tr>
<tr>
<td>1 Light limestone</td>
<td>3</td>
</tr>
</tbody>
</table>

In that part of the area in which most drilling has been done, mainly in the S.E.1/4 sec.5 and N.E.1/4 sec.8 T.26 N., R.25 W., the records show that the thickness of the chert lying just under the sandstone is a little greater than that of the sandstone passed through.
Fossils:-Fossils are of very rare occurrence in the Cherokee sandstone. Only one determinable fossil was found during three months work; this was the impression of a piece of club moss, or lepidodendron, such as are common in the Coal Measures. A few other very poorly preserved fossils were found.

Relation:-The Cherokee formation is separated from the Carterville by an unconformity. This is shown by the field relations existing just to the east of Aurora, where the tops of the formations may be found at about the same elevation, or where the Carterville may be overlain by 50 to 100 feet of Cherokee sandstone. This is not believed to be due to faulting for several reasons. First, the Cherokee and Carterville areas are too irregular to be accounted for by faulting; second, the large amount of conglomerate indicates that the Cherokee formation is filling an old stream channel; and third, this is also indicated by the great length of the area of the Cherokee as compared to its width. It should be said that the strip of Cherokee sandstone is known to continue both to the south and to the northeast. Since there is an unconformity both between the Boone and the Carterville, and between the Carterville and the Cherokee, it follows that where the former is absent there is a double unconformity between the Boone and Cherokee.
CONCLUSION

It is the opinion of the writer that the Carterville and Cherokee formations are filling old stream valleys or channels. While others may point out the contacts of these formations with the Boone as fault planes of considerable throw, it is believed that with a more detailed study they would not have reached such a conclusion. There is no reason known to the writer for believing, as the citizens of Aurora and vicinity do, that oil or gas may be found by deep boring on Sand Ridge. However, it is believed that careful prospecting by drilling along Sand Ridge will greatly widen the lead and zinc mining area.