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DEPOSITIONAL EQUIVALENT OF HIATUS AT BASE
OF OUR COAL MEASURES; AND THE ARKAN-
SAN SERIES, A NEW TERRANE OF THE
CARBONIFEROUS IN THE WESTERN
INTERIOR BASIN.

BY CHARLES R. KEYES.

For a long time it has been known that in Iowa and the neighboring states to the south a break in sedimentation exists at the base of the coal measures. It has been noted in various places in the reports of the Iowa geological survey and reference has been made to it in various other publications. Of its real significance no hint has ever been given.

Recently the correlation of the various formations making up the coal measures has been in progress, and some exceedingly interesting results have been attained. It has been possible to compare the sections in the northern part part of the Western Interior coal field with those of the southern part. The basal horizon of Iowa and Missouri coal measures has been found to belong some 20,000 feet above the Lower Carboniferous or Mississippian. Our Lower Coal Measures are high up in the middle Carboniferous, instead of being near the stratigraphic bottom.

West of the Mississippi river the unconformity at the base of the coal measures is known to extend in a north and south direction from about the north boundary of Arkansas to the southern limit of Minnesota.

From the Mississippi river the rocks have a general dip westward. Over a considerable belt of country west of the great river the juncture of the coal measures with the underlying formations is visible. The width of this belt is from 100 to 200 miles. How much farther westward it

extends is not known, since the horizon soon is covered too deeply by the overlying strata.

On the highest parts of the Ozark dome in Missouri, the coal measures are still found resting upon the uneven channeled surface of the Lower Carboniferous. South of the southern boundary of Missouri there is no evidence that any break in sedimentation occurs between the coal measures and Lower Carboniferous formations.

How far east of the Mississippi river the unconformable relations exist is not known. However, to the points where the basal line of coal measures dips beneath the eastward sloping strata, the unconformity is everywhere observable.

The plane of unconformity at the base of the coal measures represents clearly an old land surface that was subjected to erosion for a period long enough for the tilted strata to be completely beveled off from the Kaskaskia limestone down to the Cambrian sandstones. During the interval between the deposition of the last of the Lower Carboniferous formations of the region and the coal measures of the upper Mississippi valley enormous denudation had taken place. Heretofore the extent of this erosion has been little appreciated.

The evidence already at hand indicates plainly that the surface on which the coal measures of the upper Mississippi valley were laid down was quite diversified. There were hills and vales, differing in elevation by several hundreds of feet. Some of these have been especially noted by Bain* and other members of the Iowa Geological Survey. There were broad drainage basins and deep narrow gorges†. In some localities even traces of extensive dendritic stream systems are discernible. Some of the most notable of these are those recently described by Shepherd‡ in southwest Missouri.

If we wish to get a general conception of what this old surface relief actually was, we gather something of its real character by comparing it with the relief now existing.

*Iowa Geol. Sur., Vol. I, p. 174, 1893.

†Missouri Geol. Sur., Vol. I, p. 167, 1891.

‡Missouri Geol. Sur., Vol. XII, p. 127, 1898.

The topographic contrasts are certainly nearly as marked in the old as they are to-day over the same area.

The phenomenon under special consideration has been generally regarded as local in its nature; the same, as many unconformities recurring at many places in the coal measures. That it signifies an important sequence of events has never been sufficiently emphasized. That the horizon is really a great hiatus has never been fully considered. That the interval represents a period in the history of the region of much longer duration than it took to form all of the coal measures above it is a phase of the subject never before suggested.

It has lately been shown^{||} that the present Ozark uplift is of comparatively recent date; that is, Tertiary. In considering the region as it was in Carboniferous times, the dome must be neglected, and the area regarded as forming a lowland plain, the same as the rest of the region was known to be. This is farther indicated by the fact that on the highest parts of the dome remnants of the coal measures are still found on the beveled edges of the older strata.

The oscillation of the Carboniferous shore-lines in the upper Mississippi valley has already been described in detail[§]. This evidence goes to show that immediately after the Kaskaskia beds were laid down, land existed north of the present Arkansas-Missouri boundary. This was a region of profound and prolonged denudation. South of the line sedimentation continued. The land waste from this northern district was carried into the southern water area.

The northern area, after the close of the early Carboniferous period, being an area of denudation suggests an area to which the waste must have been carried and deposited. There is also suggested a depositional measurement of the erosional period.

In correlating the Iowa and Missouri formations of the coal measures with those of the Arkansas valley a tabular

^{||}Missouri Geol. Sur., Vol. VIII, p. 351, 1895.

[§]Iowa Geol. Sur., Vol. I, p. 118, 1893.

statement of the sections appears to present the facts most clearly.

SERIES.	IOWA	KANSAS.	INDIAN TERRITORY.	ARKANSAS.
Oklahoman	Oklahoman..
Missourian.....	Missourian..	Missourian..	Poteau
Des Moines.....	Des Moines	Des Moines..	Cavaniol	Poteau*
Arkansan	(Wanting)	(Wanting)	Lower C. M.	Productive C. M. and Lower C. M.
Mississippian...	Mississippian	Mississippian	Mississippian	Mississippian.

*Not the same as Poteau of Indian Territory.

The thickness of the coal measures of the Mississippi valley is greater than anywhere else in the United States. If two east and west cross-sections, one on the north side of the Ozark dome and the other through the Arkansas valley, are contrasted, the Carboniferous series present about the following measurements:

SERIES.	NORTHERN SECTION.	SOUTHERN SECTION.
Oklahoman	1 500	1,500
Missourian	2,000	1,500
Des Moines.....	500	3,500
Arkansan	Wanting.	20 000
Mississippian	1,000	1 500

From the foregoing it will be seen that the Lower Carboniferous, or Mississippian series, with its minor divisions, is well defined in northern Arkansas. The Kaskaskia

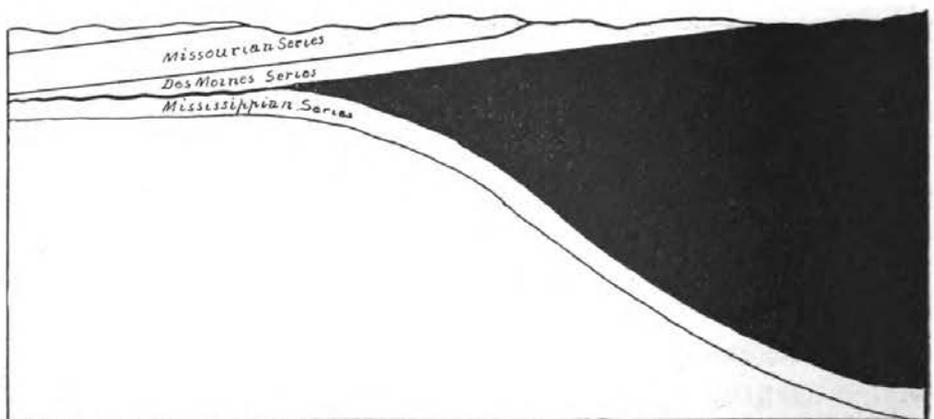


Figure 3. -- Relations of the Mississippi valley members of Carboniferous; solid black represents Arkansan.

terrane is easily identified, passing upward, south of the Boston ridge, into the coal measures.

The basal horizon of the lowest coal measures of Missouri, or Des Moines series, is believed to extend southward and to the south of the Arkansas river to coincide approximately with the Grady coal horizon or the base of the Cavaniol.

With the base of the Des Moines series of Missouri thus located in Arkansas, and the top of the lower Carboniferous well defined it leaves in the south an immense thickness of nearly 19,000 feet of sediments that are in the north wholly unrepresented by deposits. The 19,000 feet of sediments were laid down during the period represented by the stratigraphic break at the base of the northern coal measures.

The magnitude of the hiatus at the base of the coal measures of Iowa, Missouri, and Kansas is readily appreciated when we find a place where sedimentation uninterrupted attained a vertical measurement of 19,000 feet. The period of which there is no measurable record in one part of the region finds in an adjoining district sediments of greater significance than all the coal measures above the break.

Here, then, is a case in which, on the one side of an old shore-line, is the land that suffered profound denudation, and on the other the water area in which sedimentation was carried to a prodigious extent. In point of time the one is the exact equivalent of the other.

ARKANSAN SERIES.

If the recent correlations of the different sections of the coal measures in the Western Interior basin can be regarded as even approximate, there exists in the south, below the basal horizon of the Des Moines series, another great series which is now called the Arkansan series.

Heretofore the coal measures of Arkansas have been regarded as anomalous. They present an enormous development as compared with the coal measures of other parts

of the Mississippi valley, and even of other portions of North America.

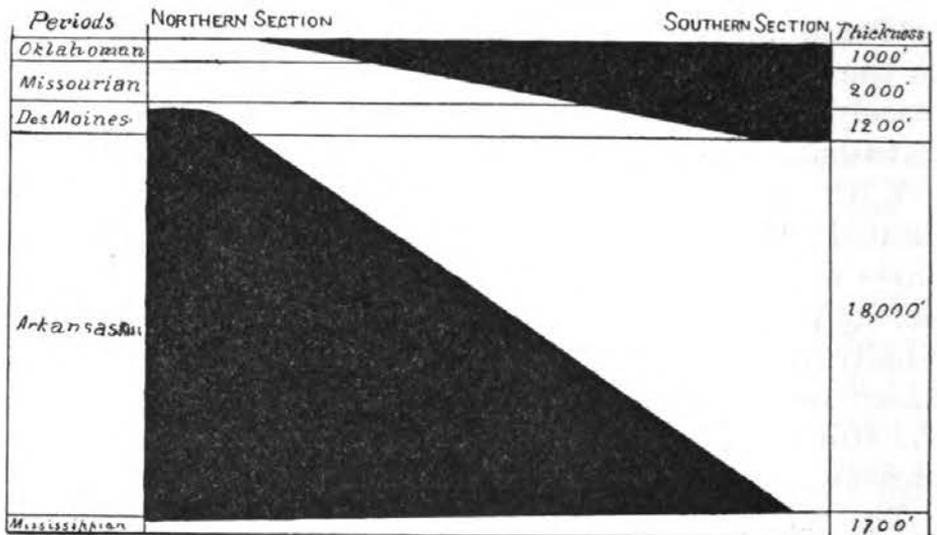


Figure 4.--Shows the relative thickness of the members of the Mississippi valley coal measures north and south.

The thickness of the coal measures of the Arkansas valley as estimated by Branner* is nearly 24,000 feet. If present correlations be correct the highest of these beds in Arkansas are not above the horizon of the Bethany limestone of Kansas. For the deposition of such an enormous sequence there must have existed exceptional conditions. The great development of the coal measures in Arkansas is not widespread, but is confined to a comparatively limited area.

The noteworthy feature in the lithology of the Arkansas coal measures is their make-up of shales and sandstones, with an almost total absence of marked limestones. While this characteristic is remarkable through such an extensive succession, it points clearly to attendant physical conditions that are unmistakable, and that are now known to be in perfect harmony with the historical record of other parts of the region.

The Lower Carboniferous formations are well understood in Arkansas. It is now known that the Boone cherts are

Am. Jour. Sci., (4), Vol. II, p. 235, 1896.

essentially the Augusta formation of Missouri, and are continuous with that formation as developed in the southwestern part of the last mentioned state. The widely recognized Batesville sandstone has been proved by Weller* without much doubt, to be the equivalent of the Aux Vases sandstone of the Mississippi river region, the basal member of the Kaskaskia formation.

It is now generally agreed that the Boston group of northwestern Arkansas is the equivalent of the Kaskaskia limestone and Chester shales of the Mississippi river. Typical Kaskaskia fossils have been found in the shales of this group in the extreme northwestern corner of the state,* and in the adjoining parts of Missouri.

The exact line of demarkation between the Lower Carboniferous and the coal measures has not been drawn in Arkansas. In the northwestern part of the state Simmonds,* without giving any reasons or data for deducing his conclusions, had regarded a thin shaly limestone (called the Kessler) lying about 78 feet above the Pentremital limestone as the topmost member of the Mississippian. As the shales beneath the Kessler limestone carry thin coal seams with an abundant flora it may be that these as well as the Kessler may eventually prove to belong more properly with the coal measures.

At present it is uncertain just where the separating line between the Mississippian and coal measures should be placed. In the Boston mountains, the stratigraphic succession is apparently unbroken from the Boone cherts (Augusta) upwards. Above the Batesville sandstone the undoubted Kaskaskian beds upwards assume more and more the character of coal measures. Into the latter the former appear to gradually merge. No evidence of unconformable relationships is anywhere noted in this region. Nor do any of the Arkansas geologists mention any facts indicating that a stratigraphic break might exist.

The zone of uncertain age is, however, thin; and the

* *Trans. New York Acad. Sci.*, Vol. XVI, p. 251, 1897.

* *American Geologist*, Vol. XVI, pp. 86-91, 1895.

* *Arkansas Geol. Sur., Ann. Rept 1888*, Vol. IV, p. 109, 1888.

basal line of the Arkansas coal measures may be regarded as determined within very narrow limits.

All evidence at hand goes to show clearly that in Arkansas, sedimentation was continuous during the Carboniferous, that enormous deposits were laid down during the period, and that while the beds were being formed there was no marked orogenic movements in the region.

From the north down to the Arkansas line the Des Moines series of the coal measures is well demarked below by the unconformity separating it from all other rocks. Its lowest horizon at this point appears to coincide with the horizon taken as the base of the Cavaniol group of Indian Territory, as traced in detail by Drake. The Cavaniol in turn is correlated in the main with the Upper or Western coal-bearing division or Poteau of Arkansas, which also includes part of the productive coal measures.

The base of the Cavaniol group is now taken to be the Grady coal. This horizon may be considered as limiting above the great Arkansan series of the coal measures. The latter is therefore entirely below the horizon of any part of the Des Moines series as represented in Missouri and farther north.

Notwithstanding its tremendous thickness in central Arkansas the unusual development may be considered as local in nature. From bottom to top it appears to represent practically the same uninterrupted deposition.

Although divisible into a number of subordinate formations it is throughout essentially a compact, homogeneous geological unit. Hence from every standpoint it is thus best considered.

The Arkansas geologists have not yet had opportunity to publish in detail their latest opinions regarding the formations or terranes which they consider as making up the coal measures of the state. Winslow's section, however, is not without interest, and is given below:

Sebastian stage	Boonville stage
Spadra stage	Appleton stage
Norristown stage	Danville stage

The conditions under which the Arkansan series was deposited are of unusual interest. The deposition of such an enormous mass of sediment as is found making up the coal measures of the Arkansas valley must have required some unusual conditions. Branner* has attempted to explain the circumstances as follows:

If we inquire into the reason for the great thickness of coal measures sediment in the Arkansas Valley, I believe it to be found in the drainage of the continent during Carboniferous times. The rocks of this series in Arkansas contain occasional marine fossils, and these marine beds alternate with brackish or freshwater beds whose fossils are mostly ferns and such like land or marsh plants. This part of the continent was, therefore, probably not much above tide level. The drainage from near the Catskill mountains in New York flowed south and west. The eastern limit of the basin was somewhere near the Archæan belt extending from New England to central Alabama. This Appalachian water-shed crossed the present channel of the Mississippi from central Alabama to the Ouachita uplift, or to a water-shed still farther south and now entirely obliterated and buried in northern Louisiana. In any case the drainage flowed westward through what is now the Arkansas valley, between the Ozark island on the north and the Arkansas island on the south.

The chief objection to this idea is, that we now know that the northern Ozark isle and the Ouachita part of the uplift did not exist as mountainous uplifts in carboniferous times. North of the Missouri-Arkansas line the region was land, to be sure, after the lower Carboniferous marine beds were laid down. South of that line sedimentation continued in deepening waters. The sediments were carried from the north or northeast and dumped off the shore, rapidly building the latter outward.

There may have been a great land area in northern Louisiana, and probably was. If so, what is now the Arkansas river valley was a broad, deep estuary opening out to the west. And the sediments came in from both sides as well as from the head towards the east. The conditions were then similar to those presented now by the Lower Mississippi plain, only the great embayment opened to the west instead of the south.

The present Arkansas valley, however, has probably been formed entirely since Tertiary times, and by a system of

*Am. Jour. Sci., (4), vol. II., p. 236, 1896.

drainage in no way dependent upon the Carboniferous drainage. Where the great uplift of Missouri and Arkansas over the northern part embraced by the so-called Ozark isle and the southern part composing the Ouachita mountains were made up of resistant limestones, these yielded less quickly to erosion than the central soft shales, and the Arkansas river which happened in the old peneplain to traverse the central part of the uplifted area was able to cut its way down as fast as the region rose and was thus able to maintain its old course. The present uplift, which is due to one general movement, is now apparently divided into two elevated regions separated by a low valley.

NAMES OF COALS WEST OF THE MISSISSIPPI RIVER.

BY CHARLES R. KEYES.

The coals of commerce acquire names by which they are widely known, and upon which their reputations stand. These names are not geological titles; and coal samples having the same name may, and usually do, come from different mines and even from different horizons. Many analyses and physical tests are made for various industrial purposes from samples taken from the railroad cars, after the latter have reached their destinations.

In the American coal fields, east of the Mississippi river, some coals noted for particular qualities are widely known by special designations. The names have a peculiar value in purely scientific work because the seams are of great areal extent. The geological positions of such coals are inferred as soon as the names are mentioned.

In the Western Interior coal field, numerous names of coals are widely known to the trade; but on account of the rather limited lateral extent of most of the seams their geological horizons cannot be easily inferred. In the following pages is given a list of all of the important coals