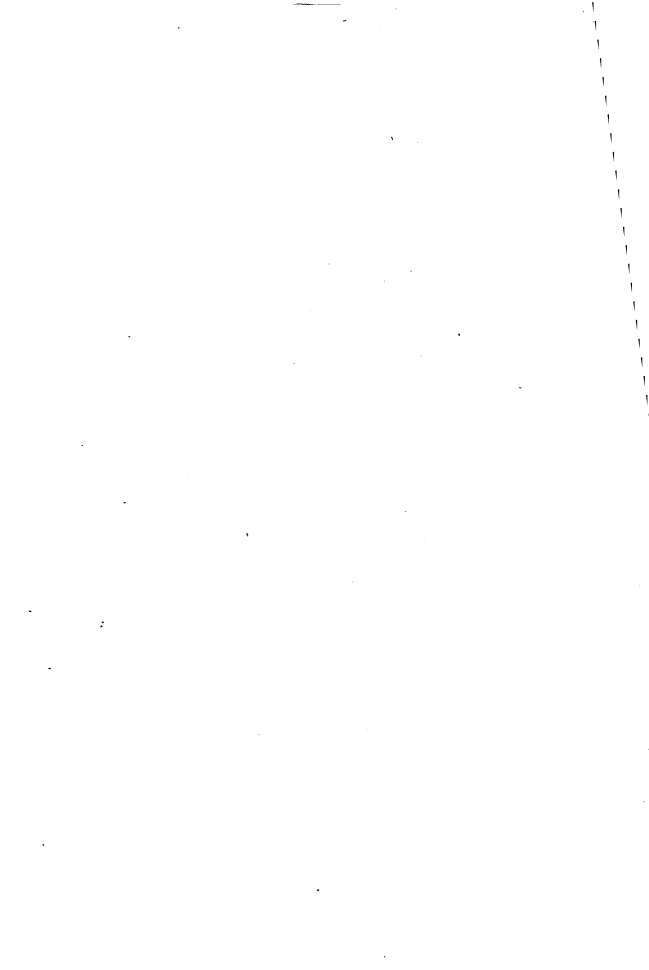

CERTAIN DEVONIAN AND CARBON-
IFEROUS OUTLIERS IN
EASTERN IOWA.

BY

WILLIAM HARMON NORTON.



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The isolated areas of rocks which occur in eastern Iowa in districts occupied by strata much older, have centered around them problems of great interest.

In modern geological work the aim is to picture as completely as may be the actual conditions prevalent over given areas during successive periods of time. In attaining this object, few determinations avail more or give a better key to the minutiae of conditions existing at any time, than the correct determination of the land and water areas. Thus, stratigraphical work often has for one of its leading objects the tracing of ancient shore lines, in which connection the study of outliers becomes especially important.

The greater part of the area under consideration is made up chiefly of Silurian strata. In Linn, perhaps two-thirds, and in Cedar one-third of the county is covered by Devonian. Its eastern margin as now mapped runs in a more or less irregular line from the northwest corner of Buchanan to the middle of the southern boundary of Cedar county. The eastern border of the Carboniferous is some thirty miles to the west and approximately parallel to it. Neither of these lines are regular, but are curved and bent through erosion of the strata.

Between the Mississippi and the known Devonian areas of northeastern Iowa is a broad belt of Silurian rocks. Within this area several outliers of Devonian age have recently been discovered.

Lying between the eastern border of the Coal Measure deposits of Iowa and the corresponding beds in Illinois is a district varying considerably in width, in which no Coal Measures are now known except such as are found in isolated and limited areas. Whether these form part of a once continuous deposit connecting the two great coal fields, or whether they are the original depositions of a series of small unconnected or partially connected lagoons, are questions of interest which still remain open. As a contribution to their final solution the results of a detailed examination of several of these outliers are presented in the following pages.

An element which complicates the task involved in the interpretation of these outliers is the close lithological similarity of certain sandstones, one being Devonian and the other Carboniferous in age. This emphasizes the fact that the determinations to be of value, must be based upon the evidence of the fossils found.

DEVONIAN OUTLIERS.

Bertram. At Bertram, Linn county, Iowa, the Chicago and Northwestern railway has cut through the side of a low hill some fifteen or twenty rods east of the bridge over Big creek, displaying the following section at the west end of the exposure:

	FEET.
3. Soil and drift	2
2. Limestone, (Bertram beds).....	15
1. Sandstone, yellowish, shaly in part.....	½

The sandstone is thinly laminated and contains many minute fragments of brachiopods and traces of vegetal remains. It is overlain and interstratified with a clay, evidently weathered from a fine-grained argillaceous shale, fragments of which it contains. The clay is usually light gray in color, but in places becomes dark and carbonaceous. This thin layer of sandstone and shale continues to the east some nineteen feet, where it dips beneath the surface. One hundred feet to the east the sandstone reappears, filling a chimney thirteen feet wide, extending from the summit to the base of the rock section. On the western side of this chimney the line of juncture with the limestone is well defined and nearly vertical. Indeed, at the top a thin layer of limestone projects beyond the edge of the sandstone. On the eastern side the line of junction is abrupt at the base, but above curves gently upward and becomes horizontal as the sandstone opens beyond the chimney to the end of the cut. The upper layer of sandstone is here two feet four inches thick and is considerably indurated. The layers beneath are thinner, for the most part fragmental, or completely disintegrated. At the base, underlying the sandstone, the same shale occurs as at the west end of the cut. Although the limestone is largely weathered into "chipstone," after the habit of the Bertram beds, the unconformity is very marked. The "burrowing" of the sandstone and shale between the layers of the limestone to some distance from the chimney seems to prove that the deposit is not a channel filling, but rather a pocket of a later deposit than the limestone. Minute fragments of fossils are not uncommon in the sandstone, but any of sufficient size to admit of identification are extremely rare. Specimens of the following genera and species were collected, showing the age of the outlier to be Devonian :

Atrypa occidentalis, Hall.

Atrypa reticularis, Linn.

Cyrtina hamiltonensis, Hall.

Orthis, near, if not identical with, *O. iowensis*, Hall, fragments.

Spirifera, fragments of three species including a dorsal valve, one near *S. subalternatus*, but more nearly semicircular in form and with fewer plications.

Tentaculites, indistinguishable from *T. spiculus*.

Acerzularia davidsoni E. & H., fragments of coralla, each with several cells.

Lisbon. A sandstone apparently the same as the one just described occurs one-third of a mile southeast of Lisbon, in Linn county (Tp. 82 N., R. V W., Sec. 12, SW. qr., SE. $\frac{1}{4}$). Here on the side of a hill there is a small outcrop of a soft, light colored or white sandstone weathering to yellowish or brown. It contains a few small nodules of greenish clay and in places is so friable that it has been used in the neighborhood for scouring. It contains a few silicified fragments of brachiopods, none large enough to identify except one which seems to be a fragment of *Atrypa reticularis*, Linn., but bearing a general resemblance to those from the Bertram outlier. The base of this sandstone lies thirteen feet above the water of the adjacent creek. It is about ten feet thick, abutting directly against the LeClaire limestone which here rises ten feet above it and in adjacent hills considerably higher still. Across the creek the LeClaire outcrops a few rods to the east; also to the north, and to the south, so that this body of sandstone must be limited to the present valley of the creek and does not extend a distance of more than eighty rods.

About two miles south of Lisbon a similar sandstone occurs in the northwest corner of section 35 (Tp. 82 N., R. V W.). Some twenty years ago it was quarried for cellar walls, but the excavation has been filled long since, and now the site is marked only by a few small

fragments of a reddish yellow, rather soft sandstone, scattered over a few square rods in a cultivated field.

Clear Creek. Along the banks of this creek, near the northwestern corner of Cedar county (Tp. 82 N., R. IV W., Secs. 28 and 29), sandstone outcrops along a line measuring from east to west nearly two miles. In only one place, on the farm of Peter Bore, is it exposed in the ledge. This is three feet thick, thirty-five feet long, and rests directly and unconformably on the LeClaire dolomite. The sandstone here is massive and indurated. Blocks have been quarried eight to twelve inches thick and two to three feet long. It is thirty-five feet above the flood plain of the creek, and, as indicated by fragments of sandstone, may extend thirty rods to the north.

Elsewhere along Clear creek the sandstone is in the form of weathered, rudely hemispherical boulders of disintegration, partially embedded in the soil of the steeply sloping hillsides. The largest of these is fifteen feet long and five feet high, but the most of them are much smaller. The shallow depression in the LeClaire, once no doubt occupied by a continuous body of sandstone, must be narrow, since, except at the place just mentioned, it does not appear on the south branch of the creek, where the LeClaire stands out in bold, massive ledges fifteen to sixty feet high, and is not found in the valley of a small stream running parallel to Clear creek a few rods to the north. No fossils have been found in this bed and it is placed with the Devonian outliers only because of general lithological similarity and because it is but two miles distant from the Lisbon outlier which lies directly west.

Lithologically little or no difference exists in the sandstones of the outliers described. All are fine-grained, normally friable and light colored, but weathering into

firmer rock, of reddish and yellow hues and gray or brown surfaces. While at Lisbon and Bertram part of the rock is friable, other portions are as indurated as elsewhere.

Canton. A yellowish gray sandstone, similar to those described above, outcrops about half a mile north of Canton in Jackson county (Tp. 85 N., R. 1 E., Sec. 18, SW. qr., NE. $\frac{1}{4}$). It occupies a narrow shelf in the Upper Silurian limestone, sixty feet above the present flood plain of the Maquoketa river, and extends east and west along the south slope of the hill a distance of about eighteen rods. The total thickness as defined by outcrops of the Upper Silurian both above and below it, cannot be over twelve feet. As shown in a well on the crest of the hill the limestone there rises between twenty and thirty feet higher than the sandstone. The latter, which occurs in a field in scattered boulders and with one or two ledges a foot or more high, presents nothing to differentiate it from perhaps a dozen or more other outliers of sandstone in northeastern Iowa. Fortunately, however, at the western end of the outcrop on the brow of a hill, a road crosses it, displaying a very interesting section. On the west side of the road there are noticeable some small, badly weathered boulders of brecciated limestone, which in the structural and lithological characteristics of its fragments and matrix are indistinguishable from the lower portions of the Fayette breccia of the Devonian. Three of these boulders were found and half a dozen rudely oval nodules of quartz with pitted surfaces, the latter peculiarly characteristic of the Kenwood shale, which in Linn county lies beneath the Fayette breccia. On the same side of the road the sandstone is exposed in a small gully for a distance of nearly two rods. Above this lies a stiff, gray or greenish unctuous clay, in places highly arenaceous, in others nearly

free from sand. It extends five rods up the hill. This clay had been scraped clean in working the road and the surface was substantially free from foreign material. On the weathered surface of the clay, fragments of silicified Devonian fossils are quite plentiful. They comprise *Acerrularia davidsoni*, *Atrypa reticularis*, *Orthis iovens*, a *Strophodonta*, several species of *Spirifera*, one indistinguishable from fragments of a *Spirifera* at Bertram. Specially numerous were the rostral portions of the ventral valve of *Cyrtina umbonata*, Hall, their preservation being due to the fact that this portion of the shell is strengthened by the cardinal area and mesial septum. Still more abundant were fragments of simple rugose corals, and of favositids.

The occurrence of these remnants of Devonian beds of considerable thickness thirty miles east of their nearest outcrops was entirely unexpected. With the exception of the outliers above described, no Devonian outliers had previously been known in the state and none had been found in this region resting on the rocks of an earlier geological age. It therefore becomes necessary to consider, and if possible disprove every other working hypothesis of the presence of these Devonian fossils and boulders at Canton. Any suggestion of a fortuitous mingling of Devonian drift from northwestern outcrops with the sandstone and clay of a Carboniferous outlier was seen to be quite untenable. The fragments of fossils were silicious, specifically identical with forms from the Devonian sandstone at Bertram. The distribution of Devonian rocks and fossils was exactly conterminous with the outcrop of sandstone and clay on the west side of the road, being found along its entire extent and entirely absent both above and below. Further, this outlier is

situated near the margin of the driftless area. The drift here is thin and inconstant, forming a thin, pebbly layer resting on geest or intermingling with it. No drift appears along the outcrop of the sandstone and clay, but seven rods farther up the hill the rottén Upper Silurian limestone is overlaid by a foot of residuary chert and clay mixed with pebbles of the northern drift. The boulders of Devonian limestone and breccia show no indication of transportation by water or ice. Fossils and breccia fragments are in relief. The surfaces are irregular and pitted. The quartz nodules retain their original form and their surfaces are vesicular from dissolution of associated calcite.

To be doubly sure of the relation of the fossils, breccia boulders and quartz nodules, to the clay and sandstone, a hole was dug in the undisturbed bank by the roadside, giving the following section :

	FEET.
3. Soil, passing below into clay.....	½
2. Clay, stiff, reddish brown, free from pebbles (passing below into number 1)	1
1. Clay, stiff, greenish-gray, sandy, non-calcareous, containing silicified fragments of Devonian fossils	1½

The fossiliferous clay overlies a sandstone, which in turn rests upon a clay, as shown by the fact that a few years since an excavation was made in the middle of the road, and fire-clay was found to extend to a depth of six feet. The intimate association of clay and sandstone is shown by the following section on the east side of the road, where the bank is six feet higher than on the western :

	FEET.	INCHES.
6. Soil, passing into loess	1	
5. Loess, fine buff loam, rather stiff, with the lower inch a transition in color and texture into number 4	3	
4. Clay, fine, white, unctuous, with rounded fragments of sandstone		4
3. Clay, light brown, resembling fire-clay.....		2
2. Clay, light red, as above, with fragments of reddish sandstone.....	1	4
1. Clay, white, as above	1	

On the same side of the road no Devonian limestone or fossils were found. The width of the outcrop is the same on both sides.

One mile northeast of this outcrop there occurs at the head of a gully on the northeast $\frac{1}{4}$ of the northeast quarter, of section 18 (Tp. 81 N., R. 1 E.) a bed of the same clay six feet thick, intermixed with sand and becoming more sandy toward the base. The clay in this gully and that on the roadside have been used for making fire brick for a furnace used in distilling wood-alcohol at Canton and found to be admirably adapted for that purpose.

This clay is said also to outcrop some five miles to the southwest of the above exposure. Though at this point the clay contains fragments of sandstone, no blocks of it appear on the surface.

The little deposit of foreign rock on the brow of the Canton hill is full of meaning. Hitherto there has been no evidence that the Devonian sea ever transgressed the present western boundary of the Upper Silurian in Iowa. This outcrop affords proof that the ancient shore line must have extended at least as far east as Canton. It hardly can represent rocks deposited in some shallow estuary, connected with the Devonian ocean to the west.

More probably it represents one or more distinct beds of the Devonian series elsewhere of considerable thickness and deposited under oceanic conditions. Quartz nodules are common only in the Kenwood shales, though one is sometimes found in the Fayette breccia. The hard drab limestone with conchoidal fracture which forms the fragments of the Canton breccia characterizes a definite horizon of the Lower Devonian from Davenport to Fayette. It lies above the Kenwood shales of Linn county and where its beds are disturbed forms the lower portion of the Fayette breccia. It demands oceanic conditions for deposition and probably for brecciation. The fossils, if unassociated with sandstone and clay, would be referred to no horizon lower than the coralline beds above the breccia. The sandstone and clay are of doubtful position. They may be the Montpelier, or they may be related to the arenaceous material sometimes found associated with the matrix of the Fayette breccia.

It seems, therefore, highly probable that the strata of the Lower Devonian and, perhaps, some of the Upper Devonian, were laid down as far east as the western part of Jackson county and have since been removed by secular decay and erosion. It is a mere accident that in one place, at least, their remains were preserved from the ice invasions on the lee of a hill of obdurate Upper Silurian dolomite, at the margin of the driftless area.

Another outcrop of similar sandstone associated with similar clay was found two and one-half miles northeast of Canton (Tp. 85 N., R. 1 E., Sec. 9, SE. qr., SE. $\frac{1}{4}$). The outcrop extends a few hundred yards along the upper slope of a hill as scattered boulders. The clay is disclosed in a road thirty or forty feet below. No fossils were found.

CARBONIFEROUS OUTLIERS.

Marion. At several points between Marion and Cedar Rapids, as in the cuts of the Chicago, Milwaukee and St. Paul railroad, and on the old county road, sandstone has been found resting unconformably upon limestone of Devonian age. The sandstone is gray, yellowish, or brown in color, of medium grain, and sometimes contains fragments of woody tissue highly ferruginated. At Kenwood there is a drab, non-calcareous shale about three feet thick. A well twenty-three feet deep, recently dug one and one-half miles south of Marion (Tp. 83 N., R. VII W., Sec. 12, SE. qr.), penetrated, immediately below the drift, a bed of dark shale which, at the depth of twenty-one feet from the surface carried characteristic remains of Coal Measure plants. The species identified were: *Neuropteris rarinervis* Bunb., *N. flexuosa* Sternb., *N. loschii* Brgt., *Alethopteris serlii* Brgt., *Annularia longifolia* Brgt., *Sphenophyllum schlotheimii* Brgt. and, doubtfully, *Rachophyllum corallinum* Lesqrx. A number of fragments were in a condition which prevented only a more or less probable reference to the following: *Megalopteris* sp.; *Cyclopteris* sp.; *Pseudopecopteris* sp.; *Neuropteris clarksoni* Lesqrx, *N. acuminata* Brgt., *N. plicata* Sternb., and *Sphenopteris trifoliata* Brgt. Uncertain as the identification of several of these fragments must remain, it is well to notice that all the species in the above lists are found in localities in Illinois, referred by Lesquereaux to Coal B with the exception of *Neuropteris acuminata* and *Sphenopteris trifoliata*. The former is of uncertain horizon and the latter is found at Clinton, Missouri. Associated with the vegetal remains is a *Spirorbis* marked by microscopic, transverse, converging striae of varying thickness and referred provisionally to *Spirorbis*

anthracosia Whitfield. In the same well, probably above the plant remains, was found a fine *Soleniscus newberryi* Hall. About forty rods south of the well just mentioned, a shaft fourteen feet deep located on a hillside at a station perhaps twenty feet lower than the well, passed through light gray and yellowish, argillaceous, fissile shale, micaceous and containing brownish vestiges of vegetal matter. This overlaid four feet of friable sandstone, yellowish, fine-grained and micaceous.

Monmouth. This outlier was first reported by Osborn. It lies about three miles south of Monmouth, on Bear creek, in Jackson county. The main body of sandstone lies in Tp. 84 N., R. 1 E., Sec. 32, SW. qr., S. $\frac{1}{2}$, and the SW. qr., SE. $\frac{1}{4}$, and in Sec. 31, SW. qr., SE. $\frac{1}{4}$. It occupies a shallow erosional trough in the Upper Silurian limestone, twenty rods wide and nearly a mile long, extending nearly due east and west parallel to the valley of Bear creek, and a short distance from the northern line of Clinton county.

Three quarters of a mile to the northeast, from the eastern end of the main body of sandstone, on a line parallel to the general course of Bear creek, there is another outcrop (Tp. 84 N., R. 1 E., Sec. 33, NW. qr., NE. $\frac{1}{4}$) and about a mile west of the western edge of the main body of sandstone there is a third isolated remnant of the same formation (Tp. 84 N., R. 1 W., Sec. 36) in Jones county. The total length of this outlier from east to west is about three miles.

The eastern outcrop is about twenty rods long and fifteen rods wide. No distinct ledge appears, but boulders of sandstone are numerous, often contiguous, and are evidently fragments of disintegration from a parent mass immediately subjacent. The thickness of the sandstone

here is estimated at about forty-five feet, though sandstone boulders strew the steep hillside to the creek bed seventy feet below the supposed bottom of the sandstone. The base is marked by the presence of a coarse sandstone with sparse pebbles and the near presence of an outcrop of the limestone. Between the outcrop first described and the main body of sandstone the valley of Bear creek intervenes, here making a sharp bend to the southeast and returning again to the northwest inclosing a "hogsback" about sixty feet high of Silurian limestone.

The eastern outcrop of the main body of sandstone is in a little gully recently washed out high up on the side of the bluff. In places it is some twenty-two feet thick. From this point the sandstone stretches westward for a distance of a mile, outcropping at the head of a ravine and on the bluff sides in long ledges from two or three to twenty-five feet high. It is evidently one continuous body except where a narrow deep ravine passing north into Bear creek severs it, affording on either side an excellent section of the trough in which it lies. The maximum width of the trough is about twenty-five rods. The depth of the trough is defined by underlying limestone. Its base is about fifty-eight feet above the creek. The limestone rises on each side to a height of twenty-eight feet above the base of the trough, whose depth, as measured from the highest limestone in the hills, is upwards of sixty feet. Here, as at the eastern outcrop, the basal member is a pebble-bearing layer two to three feet thick. It reaches to within a few inches of the limestone beneath. In its lower portion it becomes a true conglomerate. Its pebbles attain the diameter of three and one-half inches, and consist mostly of clear quartz, and chert indistinguishable from the chert of the Upper Silurian. Occasional pebbles of red jasper and pink

quartz occur. It is hardly in place at present to separate this conglomeratic mass from the Rockville conglomerate, which is only twenty-six miles away, merely by the absence here so far as observed of the pebbles of granitoid rocks which are sparingly found at Rockville. The total thickness of sandstone here exposed is some thirty feet.

On the west side of the ravine immense boulders, one thirty feet long and fifteen feet high, lie prone on the upper portion of the slope which reaches at this point to the base of the present escarpment. These once formed the face of the sandstone cliff, and have been detached by the secular decay of the calcareous floor beneath, or possibly by the removal of shales or friable sandstones subjacent.

Throughout this outlier, the rock is practically homogeneous, with the exception of the basal member containing pebbles. It is a moderately hard sandstone of quite fine and uniform grain, becoming harder on weathering. Its normal color seems to be a gray, but it is usually colored various tints of buff or light reddish, by the presence of iron peroxide and darkens on weathering. In the natural ledges quite regular and constant bedding planes appear and blocks from eight inches to two feet thick have been quarried for local use, such as foundations and the abutments of bridges. After an exposure of twenty years in an abutment the freshness of tool marks show that the stone has suffered no superficial disintegration. In places the rock is more massive, no clear and constant bedding planes appearing for a distance of from six to fifteen feet. These massive layers, as well as the thinner ones in many places are shown by weathering to be effected with oblique laminations, inclined at various angles, usually low and sometimes quaquaversal, the laminae being from a fraction of an inch to a few inches in thickness. Fossils are

extremely rare, none being found except a *Lepidodendron* log four feet long, a fragment of a calamite and a flattened trigonocarp-like nut. Nodules of green or grayish clay an inch or less in diameter are also rarely seen. Beautiful ripple marks remain on some of the blocks, as evidence of the pulse of the waves of the ancient sea along whose margin these sands were laid.

OUTLIERS OF INDETERMINATE AGE.

Andrew. The sandstone of this locality lies three miles north of Andrew, in Jackson county. The outcrop occurs along or at the base of three ravines which slope westward into Farmer creek and are ranged along a line extending north-northeast some fifty rods. The sandstone rests on the Upper Silurian limestone about thirty-five feet above the creek and protrudes from the soil in rough boulders to a vertical distance of forty-five feet above its base. This is said to be the only sandstone found in the neighborhood. The stone is of moderately fine grain, indurated superficially, reddish yellow, or gray within, but deeply stained a dark purplish red or an iron black on the exterior.

Charlotte. The chief outcrop of this sandstone is a mile north of Charlotte, in Clinton county, on the north side of Willow creek (Tp. 83 N., R. IV W., Sec. 22, SE. qr., NW. $\frac{1}{4}$). The ledge is eleven feet high, with a probable extension below of five feet. It is ten rods long and twenty feet above the water in the creek. Eighty rods to the north the *Pentamerus* beds of the Niagara, containing *Cerionites dactyloides*, overlook the sandstone. The ledge resembles those at Monmouth showing layers a foot or more thick with discordant oblique lamination. In small pieces

it is quite friable and on fresh surfaces shows various shades of gray, yellow and brown.

The same sandstone occurs at several other places in the vicinity; one mile east of Quigley and also one mile southeast of the ledge described. This and the Andrew outlier are probably Carboniferous.

The following estimates of the heights above sea level of the outliers mentioned are based upon measurements taken with an Abney hand level "tied" to the contour lines of the atlas sheets of the United States Geological Survey. They are, therefore, only approximations:

	FEET.
Bertram.....	720
Lisbon.....	833
Clear Creek.....	815
Canton.....	795
Marion.....	800
Monmouth.....	800
Andrew.....	890
Charlotte.....	760

It seems probable that the Carboniferous outliers of eastern Iowa have relations both to the Coal Measures of Illinois and to those of Iowa. The connection is close between the sandstones of Jones, Jackson and Clinton counties, and the outposts of the Illinois coal field in Scott and Muscatine counties. Still nearer to these outposts are the outliers along the Iowa river above Iowa City. From the latter it is but little over ten miles to the outlier at Marion. On the other hand the Iowa river outlier extends to the Lower Carboniferous above Marengo, and is even nearer to the Iowa coal field to the southwest than to the Illinois coal field to the southeast. Toward the north the Iowa coal field has several eastern outliers; and toward the south in Washington county

such outliers bridge nearly half the width of the Lower Carboniferous. The hypothetical eastward extension of the Iowa coal field into Jackson county to join the Carboniferous outliers there receives, perhaps, some support from the previous eastward extension of the Iowa Devonian into the same county as already noted. The views of Hall and White that the scattered sandstones were once laid down in isolated basins becomes less probable with each outlier discovered. Those now known are so numerous and widely distributed that they seem rather to support the view, that over the depressed area of eastern Iowa the central and western coal fields were broadly joined, or united along a somewhat intricately dissected coast, the most northern known limit of shore or estuarian extension being in Jackson and Linn counties.

