DIMENSIONS OF THE CINCINNATI ANTICLINE.*

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HISTORICAL.

The structure mentioned in our subject was recognized in 1838 by Locke,† who was in the employ of the Geological Survey of Ohio. He was making a survey of southwestern Ohio and after examining feeble local dips "in all possible directions," he observes that "when we examine the several formations on a large scale, the true dip becomes very evident; and as one formation sinks gradually below the surface, and another superior one presents itself, they give rise to those important changes in the face and products of the country." In correspondence with Owen, of the Indiana Geologic Survey, Locke also discovered that the strata lay similarly in Indiana, but that they dipped gently westward, while in Ohio they descended eastward. The dips thus recognized were so feeble that contact instrumental measurements could not disclose them, but through careful work with leveling instruments over considerable distances the actual dips were established.

Locke does not call it an anticline, but he clearly recognizes the structure, for he says, "on ascending the Ohio River eastward (from vicinity of Cincinnati) we meet with the blue limestone, cliff limestone, slate (shale), fine sandstone, conglomerate and coal, while descending the Ohio westwardly we meet with the same things in the same order."

In 1873 Newberry‡ discussed the structure and formations in Ohio and distinctly recognized and named the Cincinnati Arch. He says its axis is through Bethel, Ohio, and its breadth in Kentucky is 130 miles, but narrower in Ohio. He adds as confirmation that "outcrops of Corniferous (Devonian) limestone, which may be said to form its base on either side, are 150

* Presented before Sec. E, A. A. A. S., Cincinnati, O., Dec. 29, 1923. Published by permission of Dr. J. A. Bownocker, State Geologist, Geol. Surv. Ohio.

† Locke, Prof. John, Geol. Surv. Ohio. Sec. Ann. Rept. W. W. Mather, 1838, p. 206.

‡ Newberry, J. S., Geol. Surv. of Ohio. Vol. I, pp. 1–103.

miles apart in Kentucky and only 50 in northern Ohio.* He also observed that east dips were stronger than those to the west, but that all were very weak, mentioning 11–40 feet per mile. He also states that there are two folds in the crest of the main structure in northern Ohio.

Robt. R. Bell, of the Canadian Geologic Survey, has reported the geanticline as far north as Lambton, Ontario, at the southern end of Lake Huron. It is very low here and cannot be traced much, if at all, beyond this point, but it has here been a very productive source of fuel. Hall† recognized the Cincinnati Geanticline or Uplift, as it is variously called, and discussed its age and relation to Paleozoic seas, but as such matters do not fall within the scope of this paper, they will be all passed over.

In 1866 Gorby‡ devoted a dozen pages to a discussion of the Wabash Arch, which is the westward branch of the Cincinnati Anticline. This westward branch, says Gorby, possesses "absolute evidence of an upheaval extending from the northern part of Indiana near the Ohio line, northwesterly by Chicago to the regions of Lake Superior." (p. 240). He even follows a "learned paleontologist" in the suggestion that "this line or axis of upheaval is a projection of ancient disturbances, which originated in the volcanic regions of Lake Superior." (p. 229). There seems to be no reason, however, to consider the structure beyond Kankakee, Illinois, for it is well flattened out at the Illinois-Indiana line and seems to be lost near that place.

In 1893 Cubberly§ discussed the distribution of the Trenton limestone in Indiana by means of a map and a series of sections in various directions across the state. These sections and maps were based on many drill logs. The report shows the course of the Wabash Arch. It probably divides from the Cincinnati Arch a few miles south of Cincinnati, so that its axis is recognizable at Patriot, Indiana, and may be traced northward to Brookville, where it begins to divide again. Two folds or swells, one 6–8 miles west of Richmond, and the other 5–6 miles west of New Castle, are separated by a shallow sag and fuse again

* Geol. Surv. Ohio. Vol. I, 1873, p. 99.

† Hall, James, Pal. of N. Y. 1859. Vol. III.

‡ Gorby, S. S. Dept. of Geol. & Nat. Hist. of Ind. 1886. 15th Ann. Rept., pp. 228–41.

§ Cubberly, E. P. 18th Ann. Rept. Geol. Nat. Hist. of Ind., pp. 219–255.

into one toward Muncie and Anderson and beyond to Logansport. Near Rensselaer the arch again divides for a short distance as in northern Ohio.

In 1922 Malott* called attention to the trend of the axis in Indiana and to the relation of the arch to the strata and to topographic forms.

These two axes, one in Indiana, the other mainly in Ohio, if followed southward are found to unite just south of Cincinnati into a single broad swell or geanticline, which attains its maximum altitude as a structure in Jessamine County, Kentucky, in what is called the Jessamine Dome.

Toward the south the anticline can be traced easily across Kentucky and Tennessee into northern Alabama. The structure flattens out about 75 miles southwest of the Alabama-Tennessee line and passes under Cretaceous sediments. Becker† suggests that the Mesozoic and Tertiary strata of the coastal plain south and westward from this place show a broad low fold which can be traced across Mississippi and Louisiana. This of course is much later than the Cincinnati Anticline in as much as the latter was uplifted, arched and base leveled before these more recent beds were laid down. Hence it would probably be wiser not to consider such a structure as a part of the Paleozoic Cincinnati Anticline at all.

Summing up then we have a great Y-shaped structure whose south pointing stem is at least 300 miles long, whose eastern arm is of equal length between the fork and Lambton, Ontario, and whose western arm sweeps in a broad curve toward Kankakee, Illinois, with a length of 225 miles from the fork.

The anticline must be thought of as a structure and not as a form. While strata are everywhere in it arched into a grand, broad, low fold, the land along the crest is no higher than in other parts, and often not so high by a few hundreds of feet as the cuestas of flanking harder layers outcropping parallel with the axis.

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* Malott, Clyde A. Ind. Geol. & Nat. Hist. Pt. 2. p. 127f.

† Becker, oral communication at Cincinnati meeting Sec. E. A. A. A. S. Dec. 29, 1923.

THE SECTIONS.

In order to carry forward this study, a series of structure sections have been drawn crossing the Anticline at selected places. Each section is essentially at right angles to the axis where drawn, and all are drawn on the same scale. In order that the arching may be visible, the horizontal and vertical scales hold such relation to each other that the vertical is exaggerated eight times. This makes the structure seem higher than it is, and portrays the dips much steeper on the flanks than they really are. We have, from its discovery, been told that it is a broad low arch, dome, fold, or anticline, but if one examines these sections and recalls that the vertical has an exaggeration of eight, he will be more than ever convinced of the value of the adjectives broad and low.

Since the relief of the land is so slight and generally more closely related to streams and valleys than to the structure of the anticline, the surface of the land is usually represented by a straight level line. A few valleys show and are so designated. The total relief over the whole area except for a few knobs in eastern Kentucky and others in central Indiana, probably does not exceed 1000 feet and this is so slightly related to the structure that it has been omitted. In the original drawings the horizontal scale was 4 miles to the inch and the vertical one-half mile to the inch. In the reductions for publication both are greatly reduced, but the ratio has been preserved. All sections are drawn and reproduced on the same scale. The sections are about one degree of latitude or 70 miles apart. The southern (No. 1) is in Tennessee and approximately on parallel 36° N., though lying obliquely across it. No. 2 in southern Kentucky, makes a small angle with parallel 37° N.; Nos. 3, 4 and 5 are respectively, essentially upon the next three parallels, while Nos. 6 and 7 are balanced obliquely, but not quite symmetrically on parallel 41° N. No. 6 is from northern Ohio, and No. 7 from northern Indiana. The sections were drawn from the four state geologic maps; Indiana on a scale of 4 miles to the inch, Ohio and Tennessee 8 miles to the inch, and Kentucky 12 miles to the inch. A contour map could be drawn on the Trenton if we had enough data. Well logs furnish excellent material if properly kept, and in most of Indiana and northern Ohio they are sufficient, but in other parts not yet available.

INTERPRETATION OF THE SECTIONS.

Section No. 1. Nashville Dome on the Anticline (Nashville Basin topographically) and this section cuts obliquely across it, N. W.–S. E. The anticline is here 120 miles across and 3,600 feet high. East dips average about 55 feet in a mile and west dips 50 feet.

Section No. 2. Intersects a sag in the crest, between the Nashville and Blue Grass basins or the Nashville and Jessamine domes. The structure is 140 miles wide and rises 2,100 feet on the west, but only 2,000 feet on the east. East dips are again steeper making this limb shorter. East dips average about 42 feet, west dips about 22 feet to the mile.

Section No. 3. Jessamine Dome. Width about 250 miles. Drillings show the Trenton limestone at Owensboro, near the west end of the section 3,500 feet below sea-level, and at eastern end of our section, about 3,300 feet below sea-level. Erosion has revealed the Trenton on the axis near Lexington with an altitude of 1,000 feet above sea level. Thus the structure along this line is 4,400 feet high. East dips are again much the steeper, averaging about 43 feet, and west dips about 31 feet.

Section No. 4. Crosses three states. About 35 miles in the central part is in Kentucky, while the eastern end is in Ohio and the western in Indiana. The structure here has a width of 215 miles and already shows the crest divided into two small swells, one east of Cincinnati and one west, with a sag of nearly 100 feet between them. Trenton rises in each crest to 50 or more feet above the river, showing at Patriot, Indiana, and Point Pleasant, in Ohio. The altitude attained here is essentially 3,000 feet, with dips a little stronger on the east side.

Section No. 5, A. & B. This section is divided into two parts at the Ohio-Indiana line, because it is so much longer than the others. It shows two axes clearly, one 30 miles east of the state boundary, and the other about 45 miles west. The sag between them is still very slight. The Ohio crest is 3,600 feet above the base of the eastern limb and the Wabash crest is about 2,600 feet above the western limb.

Section No. 6. Findlay dome on the east branch. The width here is 120 miles and the crest rises 2,800 feet above

the eastern limb and 1,300 feet, much more gently, above its western limb.

Section No. 7. Rensselaer dome on Wabash Arch. Section from South Bend, Ind., S. W. near Rensselaer, Remington, LaFayette and Rockville. The width is 150 miles at least and the altitude 1,600 feet, the least found anywhere.

THE UNEVEN TOPPED CRESTS.

Another item of interest is the character of the crests of the Anticline. Beginning in the south and following the top of the Trenton limestone the figures may be given.

Murfreesboro, Tenn.	950±	feet	above	sea	level.
Burkesville, Ky.	250	"	"	"	"
Lexington, Ky.	1000	"	"	"	"
Patriot, Ky.	500±	"	"	"	"
Lawrenceburg, Ind.	158	"	"	"	"
Brookville, Ind.	174	"	"	"	"
Connersville, Ind.	117	"	"	"	"
Anderson, Ind.	66	"	"	"	"
Logansport, Ind.	334	"	below	"	"
Rensselaer, Ind.	158	"	"	"	"
Point Pleasant, O.	500±	"	above	"	"
Springfield, O.	450	"	below	"	"
Kenton, O.	500	"	"	"	"
Findlay, O.	340	"	"	"	"
Fostoria, O.	600	"	"	"	"

Still lower under Lake Erie.

Thus the crests are shown to be quite uneven topped, varying from 1,000— feet below sea level under western Lake Erie to 1,000 feet above near Lexington, Kentucky, and changing dip frequently along the axis. Dips along the axes however must be exceedingly small even compared with those on the flanks.

Dimensions of the Cincinnati Anticline
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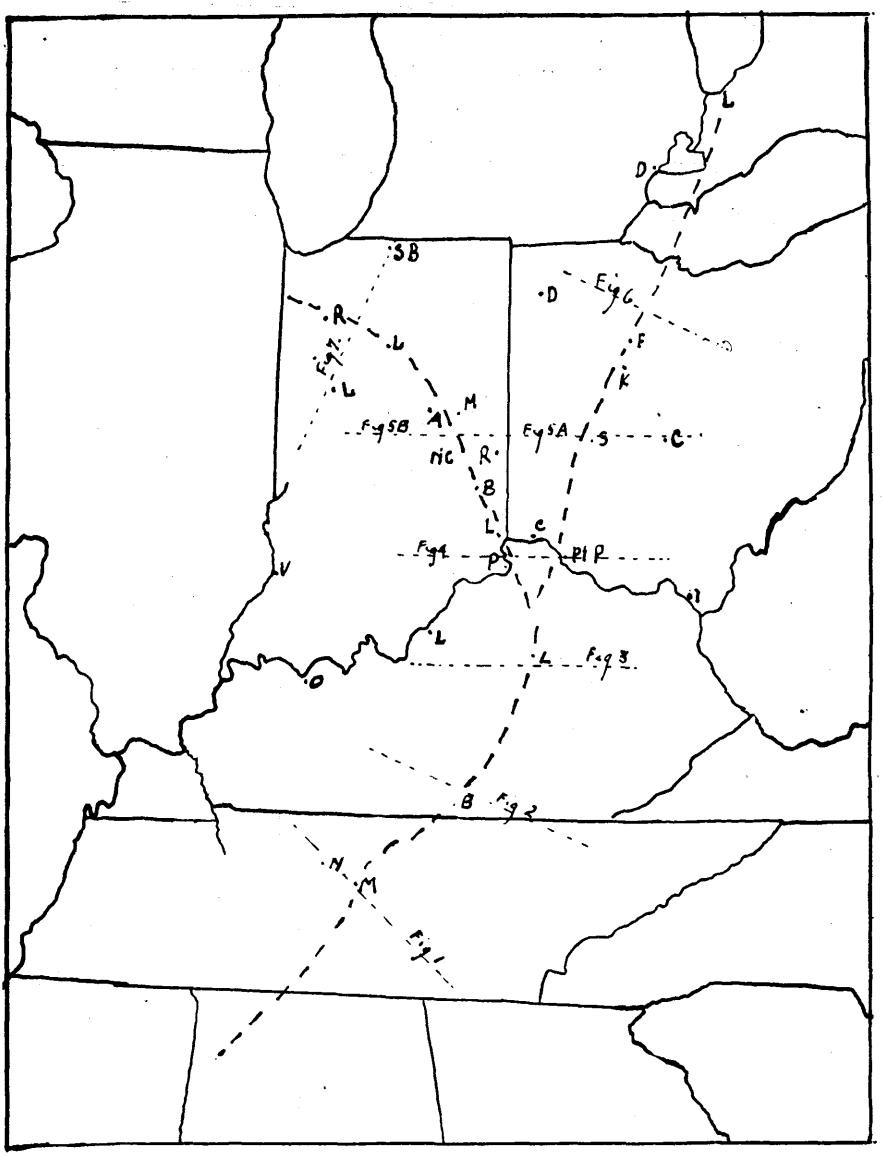
PLATE I.



The group of states in which the Cincinnati Geanticline occurs. Heavy dashes show course of the main axes with branches; light dash lines show approximately the location of the seven sections. Dots with initial letters locate approximately most of the cities mentioned in the text.

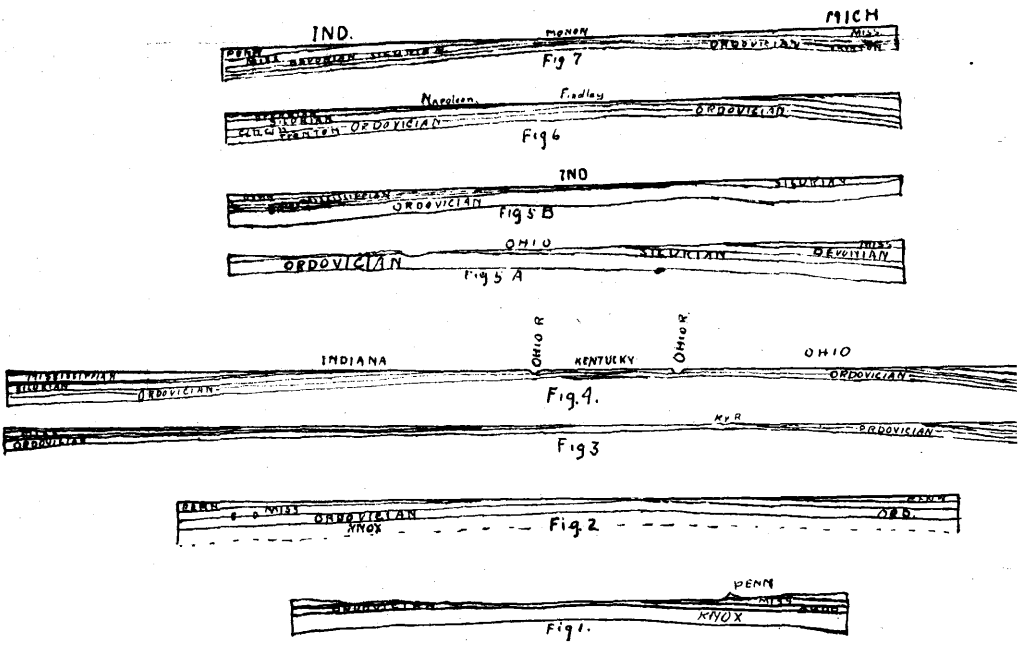


Fig. 1. Section in Tennessee basin with Murfreesboro nearly on the axis. Lower Ordovician corresponds roughly with lower Trenton of sections farther north.

Fig. 2. Structure section in southern Kentucky with Burkesville nearly on the axis. Silurian and Devonian very thin.

Fig. 3. Section through the Jessamine dome central Kentucky with Lexington near the axial line. The highest part of the anticline.

Fig. 4. Structure section along 39° N. parallel. The first section to show the two crests. Trenton is high enough to show in Ohio River on each crest but not high enough to show along river between crests.

Fig. 5. Divided into two parts, A in Ohio, B in Indiana. Two crests here 75 miles apart show clearly, one in Indiana, the other in Ohio.

Fig. 6. Structure section without all the detail across arch in northern Ohio. The three minor folds near the crest are too small to show on a section on this scale.

Fig. 7. Section nearly N-S in northern Indiana bearing same relation to Wabash Arch that No. 6 does to eastern branch. No. 6 and 7 are not continuous as No. 5A and 5B are. See Map.

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