A Subterranean Cut-Off and Other Subterranean Phenomena Along Indian Creek, Lawrence County, Indiana.

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The drainage basin of Indian Creek in Monroe, Greene, Lawrence, and Martin counties, Indiana, offers a number of interesting physiographic phenomena. Indian Creek from its source in western Monroe County southwest of Bloomington to its entrance into East White River a few miles above Shoals in Martin County, traverses a sinuous route some 50 to 75 miles in length, though the direct distance is but little more than 25 miles. The valley in the upper portion is rather broad and lies on a limestone plain which is perched from 100 to 150 feet above the more deeply intrenched streams on either side of the basin. This condition of its upper portion has resulted in wholesale subterranean piracy, and some 15 square miles in area have been diverted from the surface route through Indian Creek to the more deeply intrenched streams on either side.[1] In the middle and lower portions of Indian Creek basin the valley is very tortuous and narrow. It is deeply set in a dissected plain, the narrow valley floor lying from 200 to 300 feet below the preserved portions of the dissected plain. The upper parts of the valley sides are composed of clastic rocks belonging to the Chester series. These rocks often form benches with abrupt sides of massive sandstone facing the valley. The lower parts of the valley sides are composed of the so-called Mitchell limestone which is exposed in the steep, wall-like sides of the meander curves. Within the meander curves of the valley occur local sinkhole plains far below the dissected surface of the plain in which the valley is cut. Springs of considerable size enter the stream and furnish a large part of the perennial waters. Some of these springs are mineral springs, such as at Trinity Springs in Martin County. At one place a complex meander curve more than 3 miles in length is in the process of being cut off through the development of subterranean drainage beneath the spur of upland across the narrow neck of the meander loop. It is with this feature that the present paper chiefly deals.

The accompanying topographic sketch, Fig. 1, shows a small area of 4 square miles in western Lawrence County through which Indian Creek passes in a very sinuous route. The area lies in T. 5 N., R. 2 W. The village of Silverville lies a mile south of the area, and Armstrong station on the Bedford-Switz City Branch of the Monon Railway is about 1 mile north of the area. The area is about 9 miles west of Bedford. This locality has been mapped in particular to show the developing subterranean cut-off in Indian Creek. The locality also is

[1] See the Bloomington, Indiana, Quadrangle. Also see, Beede, J. W., "The Cycle of Subterranean Drainage as Illustrated in the Bloomington, Indiana, Quadrangle," Proc. Ind. Acad. Sci. for 1910, pp. 107-111.

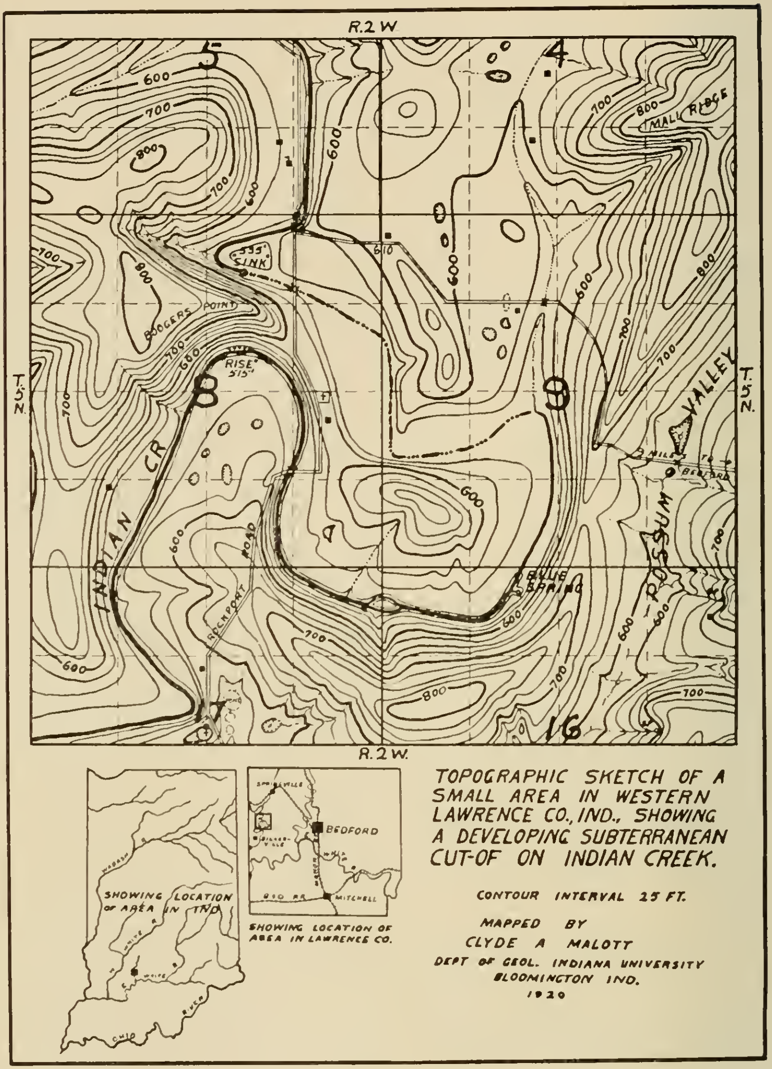

FIG. 1.

interesting from the standpoint of other features present, and these will be briefly discussed.

Indian Creek in this locality lies in a very sinuous valley and is deeply sunk below the higher upland divides. The length of the stream across the two miles of the mapped area is 5¾ miles, or nearly three times the direct distance. The stream both above and below the mapped area is but slightly less sinuous. It occupies a narrow valley which is rarely more than 200 yards in width at the bottom. It is usually at one side or the other of the narrow valley floor and at the foot of a bluff or steep rocky slope, varying from 30 to 275 feet in height. (See Fig. 5.) The most striking feature of the stream and its valley is the complex eastwardly turned meander. This meander is more than 3 miles in circuit and returns to within one-fourth mile of the place where it begins. (See Fig. 1.)

The topographic condition of the area is that of an irregularly dissected plain somewhat beyond the stage of maturity. The land forms present are far from being uniform in kind and size. Diversity rather than uniformity of land forms persist throughout the region. Prominent ridges are present, but their crests are individually uneven and rough. Rock benches frequently occur on the higher flanks of the valley sides, but are not always present there. Great sags and prominent eminences occur. The ravines are sharp and rocky, and their upper parts possess very steep descents. Local isolated sinkhole plains are present midway between the streams and the rough ridge crests. These local sinkhole plains are chiefly associated with the valleys of tributary streams in their approach to the main valley. Some of the sinkholes have become plugged and have become small lake basins. The larger topographic features and their relationships are shown on the accompanying topographic sketch, Fig. 1.

The altitudes within the area of the sketch map range between 510 and 875 feet above sea level. The maximum relief is 365 feet. The immediate relief is as much as 275 or 300 feet. The chief relief forms are the great bluffs on the outside of the meander turns, the sharp uneven sandstone ridges, and the isolated hill within the big meander loop. The curved bluffs on the outside of the meander turns are dis-

FIG. 2.

Fig. 2. View of Blue Spring, a large artesian spring which comes from a cavernous opening at the foot of the hillside adjacent to Indian Creek. The waters which have their exit here have been drained from Possum Valley which lies east of Indian Creek, and have been diverted from their former surface course through the development of subterranean channels. The region furnishes an excellent example of subterranean stream piracy.

continuous and alternate from side to side of the valley. These relief forms are in great contrast to the local sinkhole plains developed some 50 to 100 feet above the valley floor of Indian Creek.

The ridges of the area are composed chiefly of massive sandstones, though their lower and more gentle slopes are composed of the upper part of the Mitchell limestone. The sinkhole plains are developed approximately 100 feet below the top of the Mitchell limestone, or near the top of the St. Louis geologic unit. The local sinkhole areas as shown in sections 8 and 17 are somewhat lower than those in sections 4 and 9. This is in harmony with the dip of the strata to the southwest.

Features accompanying subterranean drainage are very much in evidence. Possum Valley, a small portion of which is shown on the topographic sketch, is a streamless valley which lies east of Indian Creek valley. This valley offers some interesting physiographic phenomena. As a valley basin it is some 3 or 4 miles in length. It is rimmed by sandstone ridges with the exception of the opening on the south. Its floor is occupied by numerous sinkholes and swallow-holes. Small streams descend from the sandstone ridges and hills and enter the swallow-holes in the bottom of the valley. Some of the ravines or small streams are headed by springs which commonly issue from the foot of steep sandstone bluffs near the tops of the ridges. Two such springs are shown on the topographic sketch. South of the area covered by the topographic sketch the valley is open and is occupied by a normal surface stream, Hackley Creek, which enters Indian Creek a mile or so below. Little or none of the waters which drain into the swallow-holes enter Hackley Creek. These waters apparently enter Indian Creek

FIG. 3.

Fig. 3. View showing the pool in Indian Creek channel in which the waters sink. During low water condition all the water enters the subterranean channels here and passes southward beneath "Boogers Point", re-entering the surface channel of Indian Creek after passing through a subterranean channel or channels one-fourth mile in length. The fall of the subterranean route is approximately twenty feet. The route taken by the surface stream during higher water stages is 3.1 miles in length. (See Fig. 1.)

through an underground system which has its terminus at Blue Spring. (See Fig. 2.) Blue Spring is a spring of great volume which rises out of a cavernous opening at the foot of the rocky meander curve in section 16, and enters Indian Creek channel. Little of the cavernous opening is visible, as the spring is artesian. After heavy rains the muddy waters rise vigorously and in greatly increased volume. During dry weather the pool at the opening is a deep blue color, and the water rises quietly and flows away at one side practically at the level of Indian Creek.

Possum Valley is characteristic of many valleys of its kind developed in the Mitchell limestone along the western margin of its outcrop. Such valleys are almost invariably tributaries to a larger and more deeply intrenched main stream. They have originated as valley basins through normal surface erosion in the clastic rocks of the Chester series. As the main streams were intrenched through downward erosion, the tribuary valleys were also cut down, but less rapidly than the main streams. When the tributary streams had cut through the clastic rocks to the Mitchell limestone, the main streams were already well intrenched within the Mitchell limestone. The tributary streams were thus somewhat perched above the main streams, and possessed a valley floor of limestone. Subterranean drainage gradually developed in the tributary valleys, especially at some distance from their junction with the main streams. In many cases the waters which enter the subterranean channels through the swallow-holes in the middle and upper portions of the near streamless valleys re-enter the valley at the surface and continue to the main stream as a surface stream. But more frequently the waters have been diverted through subterranean channels directly to the main stream, the waters passing beneath the divide between the main stream and the tributary. Beaver Valley west of Mitchell in southern Lawrence County is an example of semi-streamless in its upper portion, the subterranean waters of which in part come to the surface lower down in the valley basin. Possum Valley illustrates the sort in which the water has been diverted by subterranean piracy.

It should be noted that there is a distinct difference in the manner of stream diversion in subterranean stream diversion as compared to surface stream diversion. In the latter kinds of stream diversion the diverting or pirate stream is the sole aggressor, while the diverted or captured stream is wholly passive. In the case of stream diversion through the development of subterranean drainage, the diverted stream is the chief aggressor and brings about its own diversion. Because of such a fundamental difference in the manner of stream diversion, some question arises in the mind of the writer as to the propriety of calling subterranean stream diversion stream piracy, though the expression stream diversion conveys the full meaning of the action.

Subterranean drainage takes place as a matter of economy of distance. The subterranean routes are always shorter and more direct than the abandoned surface routes. In the case of Possum Valley the economy of distance is obvious. The subterranean route under the dividing ridge is very short as compared to the old surface route below.

Streamless valleys of this sort may have one or more than one underground system, but the old surface stream is broken up into a large number of small surface systems. Each tributary of the former surface stream may become a small surface system to itself, possessing its own particular swallow-hole marking the terminus of the individual surface system.

The topographical sketch, Fig. 1, has been prepared especially to show the conditions attending the development of a subterranean cut-off, wherein a great meander loop is being abandoned on account of the development of a sub-surface route across the neck of the meander. The waters of Indian Creek in low water condition disappear at the foot of the steep slope forming the north side of "Boogers Point" spur. (See Fig. 3.) The waters reappear one-fourth mile south in a series of springs at the side of the surface channel where it has returned from

FIG. 4.

Fig. 4. View showing the place where some of the waters from the subterranean cut-off re-enter Indian Creek channel. The series of springs coming out at and slightly above water level indicate that the subterranean route beneath "Boogers Point" spur is not well concentrated.

the complex eastwardly extending meander loop. (See Figures 4 and 5.) Here again is illustrated economy of distance in subterranean drainage over the surface route. The subterranean route beneath "Boogers Point" spur is approximately one-fourth mile in length, whereas the surface route is more than 3 miles in length. The fall is approximately 20 feet, and is sufficiently great to give rise to considerable mechanical erosion along the subterranean route. Such erosion, however, is greatly lessened through the lack of concentration in the subterranean route, as it appears that the route is a diffuse one. The waters at the "sink" disappear chiefly in one pool, though other pools below the main one show indications of water loss. The waters re-enter the channel as broad streams through the accumulated talus at the foot of the meander bluff. The issuing waters extend along the stream, coming out practically at stream level, for a distance of 100 yards or more. There is nothing spectacular about either the "sink" or "rise". In high water the surplus passes through the surface channel around the great meander curve.

One may speculate on the drainage conditions here in the future. It does not appear that the subterranean route is likely to become clogged and the route shut off. The St. Louis limestone is notable throughout its outcrop in Indiana and Kentucky for its perfection of

FIG. 5.

Fig. 5. View of the meander curve against which Indian Creek channel snugly fits just northeast of the center of section 8. (See Fig. 1.) The view shows the main part of the spur forming the neck between the two limbs of the great meander curve. It is locally known as "Boogers Point". The arrow indicates the place of the re-entrance of Indian Creek waters into the surface channel. (See Fig. 1.)

development of subterranean channels. Lost River in Orange County, Indiana, has a subterranean route 8 miles in length, having practically abandoned a surface route approximately 19 miles in length. It is possible and even probable that the subterranean route will be enlarged in the future. One may consider it as developing to the stage of an open tunnel and the formation of a natural bridge. The rock of the ridge over the subterranean route is at least 200 feet thick and is competent. The lower 150 feet of it is limestone and the remainder is sandstone. If it should ever reach the open tunnel stage, it is only a step further to the open drainage stage. Such a condition is a high probability in the course of time. Each end of the subterranean route is situated on the outside of a meander curve. These curves may be expected in time to develop, and the subterranean route thus become shorter. Such will only hasten the development of the passage way to the open tunnel stage and eventually to the open drainage stage. When it has advanced to either one of these stages the present circuitous meander channel may be abandoned. If this condition is ever attained the meander route would no longer be considered a part of Indian Creek or Indian Creek valley. But it is more likely that the circuitous meander route will be retained through the continued action of the flood waters, as it is to be kept in mind that erosion is chiefly accomplished during high water stages in areas of topographic youth and maturity. Still another possibility is suggested by the wash on the west side of the road in the northwest quarter of the northeast quarter of section 8. Should this wash develop sufficiently the "sink" would be abandoned through the development of a surface cut-off, thus causing the abandonment of the present developing subterranean cut-off.

This drainage adjustment which is taking place through the development of an underground route across the neck of a meander loop is here called a subterranean cut-off. When once completed the result is the same as in a surface cut-off of a meander loop, whether it is in the case of a meandering stream or a meandering valley. This drainage adjustment does not well classify under stream piracy, as may be suggested and which may possibly be referred to as "self-capture". The term "self-capture" may be inferred to have a definite meaning, but in itself it is a rather impossible term. The term "subterranean cut-off" is expressive of the condition of drainage and gives a direct inference to the process, and is therefore preferable.

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