

THREE CAVERN PICTURES.

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Limestone caverns are natural subterranean runway voids which have been selectively formed below upland areas at one or more levels in limestone strata. Fundamentally they are forms resulting from water drainage through limestone beneath the surface. They had their origin in the insidious percolation of groundwaters along structural control lines, such as joints and bedding planes. These waters, charged with carbonic acid, dissolved runways sufficiently large to permit streams to freely follow them, and the runways thus initiated have been further dissolved out and eroded by the streams which coursed through them. As runways of subterranean streams, either of the past or of the present, caverns are nearly horizontal in the direction of their length, though in their outlet directions they become lower, somewhat like surface streamways. It is probable that our larger caverns once served as subterranean conduits between swallow-holes of disappearing surface streams of upland areas and large springs which issued at lowland levels in the deeper valleys transecting the limestone upland. Caverns have been or are subterranean drainage routes.

What I have to say under the caption of this brief paper has as much to do with comparative impressions or ideas as with the descriptive phenomena of three limestone caverns in southern Indiana which I have repeatedly visited in the past few years in company with students. The caverns are the well known Wyandotte and Marengo caves of Crawford County, and a little known cave at the Wesley Chapel "Gulf" of Lost River, about two miles east of the village of Orangeville, Orange County. I shall discuss these in the reverse order in which they are mentioned.

Lost River disappears in a swallow-hole, or a series of them, in its channel on the upland limestone plain southeast of Orleans, Orange County, at an altitude of about 620 feet. Its waters issue from the terminus of a subterranean conduit near Orangeville, eight miles west, at an altitude of 490 feet. The drainage basin of Lost River above the first swallow-hole comprises about 60 square miles. Below the "sink" of Lost River the waters of many tributaries disappear in swallow-holes and greatly augment the waters which rise from the slimy pit at the terminus of the underground conduit. During times of heavy or continued rains the underground channel is filled to capacity, and excess waters pass through the "dry-bed" channel on the surface. The surface channel in its sinuous course traverses a distance of 21 miles between the first definite swallow-hole and the "rise" south of Orangeville. It appears that the sub-surface conduit runs west in a nearly direct line from the "sink" to the "rise." The length of the conduit is probably

but little greater than the direct distance of eight miles. The directness of the sub-surface route is indicated by the presence of four large swallow-holes in the "dry-bed" channel where it repeatedly crosses the direct line of the "sink" and the "rise." From one of them the underground channel may be reached. The deeper and more abrupt sinkholes also occur along this direct line. Near Wesley Chapel a great "gulf" occurs, where an oblong area 600 feet wide and 1,100 feet in length has collapsed into the subterranean Lost River, forming a steep-walled depression which has a floor of several acres in extent. At the south end of this "gulf" the waters of Lost River well up in a deep, mud-lined, funnel-shaped pit. In high water periods the pit overflows, and muddy waters may cover the entire floor of the "gulf." Past floodings of the "gulf" have deeply alluviated the floor and given it a flat-bottomed aspect. The "gulf" never overflows, but the waters rising from the pit re-enter the subterranean channel through wood- and mud-clogged openings similar in character to swallow-holes. The Wesley Chapel "gulf" is perhaps the most spectacular topographic feature of the entire Lost River basin. The "gulf" is in the line of the direct course of subterranean Lost River.

It is at the Wesley Chapel "gulf" that the character of the subterranean conduit of Lost River may be observed for a short stretch. Entrance is gained through a small opening between the accumulated talus and the cliffed wall of the "gulf" on the west side near the south end of the "gulf." The opening leads down an inside talus slope with a low overhead roof of downward sloping limestone, which may once have been the roof of the subterranean channel. Immediately at the foot of the inside talus slope, some 40 feet below the opening, is the water of Lost River in its subterranean channel. In the dark quietness of the cavern the faint gurgle of the rippling eddies reaches the ear in a hollow, solemn monotone. The river here intruded upon ever courses on in its mysterious route. In flood times the cavern air is charged with a subdued rushing roar which comes from rapids and falls from some distance downstream. The water then reaches high up the inside talus slope, and here next to the water's edge gives forth but little more than a musical gurgle.

Perhaps as much as a thousand feet of the river cavern may be traversed. In places the water runs under low rock flumes, but higher side routes with clean-washed floors offer passage about the siphon-like water routes. Fallen blocks of rock are common, and they are being washed and dissolved away by the river waters which play about them. The walls of the cavern are angular-edged layers of raw limestone, practically free from travertine accumulations. By wading water of irregular depths, in places dangerously deep, one may pass down stream. The ceiling is low much of the way, but in places it is high and high-water routes pass about masses of fallen rock. Some 600 feet from the entrance the ceiling becomes low and the waters of the river descend through broken rock on the floor. Further passage appears to be barred. Upstream from the entrance passage is found partly through muddy side routes and partly in the irregular rocky floor of the stream for a

distance of perhaps 400 feet, where the water comes into the cavern river channel through masses of fallen rock. Everywhere the fallen rocks and the sidewalls are covered with a slimy mud which has settled out from the temporarily ponded flood waters of this part of the cavern.

This miserable little stretch of the underground river route gives us but a tantalizing glimpse of a mighty cavern, whose main channel length cannot be less than eight miles. Inadequate as it is, it is a sample of a big cavern in the making. Only at two or three other places may this great cavern be glimpsed, and at these places it is also ugly in roughness, slimy with mud filth, and coursed by a dangerous river. It presents a forbidding, mysterious, fearful picture to the senses, and it is impressive only when conceived as the underground conduit of a large stream more than eight miles in length and 60 to 150 feet beneath the upland surface which feeds water to it through ugly, nondescript inlets.

Marengo Cave has two outstanding characteristics which impress its visitors. These are its broad, even-floored channel course and its beautiful travertine decorations. I wish to speak chiefly of the former. For nearly half a mile Marengo Cave is essentially an underground channel which has been deserted by its former stream. It extends in a northwest by southeast direction with only such turns or bends as a surface channel of similar size would have. The floor of the cavern is 30 to 75 feet in width and is blanketed with a clay silt, in which is a channel 2 to 3 feet in depth and 10 to 20 feet in width. This channel swings from one side of the cavern floor to the other, somewhat as the channel of a surface stream in a narrow valley floor. Undercut places along the cavern walls are common. The channel bed in the clay silt has ripple marks, current-cut gouges, and spoon-shaped depressions of larger size, which clearly indicate the direction of flow of the stream that once occupied the cavern. The ceiling is 5 to 30 feet above the floor. Marengo Cave is a capacious cavern and is traversed with ease. Little or no fallen rock debris interrupt the channel floor. The only water in the cavern is that which seeps in from the roof, and this is chiefly confined to the two ends of the cavern where it is near the surface. The travertine formations of stalactite, stalagmite, and flowstone are very prolific in the two ends of the cavern where seepage is apparent. It appears that the carbonate growths, the features which both delight and amaze the visitor, have been formed chiefly since the cavern has been abandoned by the stream which once ran through it. Little other change has taken place. I would ascribe its channel preservation to the fact that the cavern is formed in rather massive beds of limestone. The cavern ceiling has a well developed arch in the massive strata, and there is little opportunity for rock collapse from the roof which would clog the channel floor. This condition was doubtless attained long before the stream, which largely formed the cavern, deserted it for a lower level.

Marengo Cave is a part of an underground route of a stream which once traversed it from the northwest to the southeast. It is near the

terminus of this former underground stream, and it probably yet connects with the surface valley swallow-holes about two miles north of the present cave. A large spring of greatly changing volume enters Whiskey Run Creek approximately at stream level about 300 yards west of the present cave entrance, which is near the upper or northwest end of the cavern. This large spring is an underground stream which issues from a cavern that is now being developed at a level some 20 to 25 feet below the abandoned stream floor of Marengo Cave. It is very likely that this stream still occupies an upper cut-off portion of the Marengo Cave system which has not yet been discovered. Whiskey Run, having been cut down to a lower level than formerly, offered opportunity for the underground tributary to seek a lower level. The underground stream has completely abandoned the lower part of its course, the present Marengo Cave, and now occupies a newer developing cavern channel from which it issues as a large spring.¹ Thus, Marengo Cave is a part of a subterranean conduit fully developed in rather massive beds of limestone—a cavern long deserted by the stream responsible for it, but which yet retains the characteristics of a water-made runway in an excellent state of preservation. In this great cavern runway have been formed the beautiful formations of stalactite, stalagmite, and flowstone, which astonish and delight the thousands of visitors who annually tread the smooth-floored channel of the former underground stream which left its tell-tale handiwork for those who may read its sculptural arcraft.

Wyandotte Cave is a complex cavern system developed at several levels. Its main galleries extend in a general north and south direction, and cross channels are present which, at a few irregular intervals, are found to connect the main galleries. There appear to be three main gallery-tiers or levels with, perhaps, one or two others of local or limited extent. The main galleries may be traversed for miles. Except in the little known and unexplored lowest level, water is nearly absent, and the dust of ages has collected upon the fallen blocks which litter parts of the cavern system. The lowest level may be conceived as one of the main levels, as it now carries the waters which have long ceased to run through any of the galleries composing the cavern system which is open to visitors. The existence of this water-coursed level is indicated chiefly by the occurrence of a large spring which issues southwest of the present entrance to the cavern system. This spring pours forth its considerable volume of water near the level of Blue River, which has an altitude of about 400 feet above the sea. The other main gallery levels are at altitudes of about 475 feet and 545 feet according to aneroid barometer measurements made by the writer fourteen years ago. The present entrance is at an altitude of about 575 feet, some 35 or 40 feet below the top of the limestone unit in which subterranean drainage is so well developed in southern Indiana and western Kentucky. The upland surfaces of the ridges between the deeply-set valleys are at

¹ See *A Preliminary Report Upon the Survey of Indiana Caves with Special Reference to Marengo Cave*, by Arch R. Addington, Eighth Ann. Rept., Indiana Dept. of Conservation, for 1926 (1927), pp. 21-31.

an altitude of 750 to 850 feet, and they are composed mainly of elastic rock strata. The Wyandotte cavern system lies wholly below an altitude of 610 feet, and at its maximum depths is nearly 400 feet beneath the sandstone ridge crests. I know little about the nearby valleys with their present swallow-holes and their disappearing streams, and I have no inkling of the sources of the streams which formerly ran through the galleries of the Wyandotte Cave system.

To the casual visitor Wyandotte Cave is a maze of passageways which connect both vertically and horizontally in a bewildering way. It is a labyrinth of galleries, rooms, and interconnecting passageways which leaves him in a helpless wonder. In a haze of bewilderment and wonder the cavern seems to be a succession of phenomena without order, system, or plan. But to the more frequent visitor who has become familiar with the phenomena of the cavern it does have order and system, and, aside from the beautiful chemically-deposited mineral accumulations which decorate parts of the cavern, two main characteristics stand out which give plan and comprehension to it. Parts of the cavern system are composed of relatively simple underground conduits, the floors of which are nearly level and covered with a yellow clay silt. These conduits occasionally have remarkably straight stretches of several hundred yards in length. They are simple, water-made runways which have been sculptured from the limestone strata by underground streams which have abandoned them, and as such they are little different from hundreds of other cavern runways developed in limestone strata as subterranean drainage lines. Other parts of the cavern system are in great contrast to the simple, dry channelways. Here the bottom of the cavern little resembles a floor. It is ruggedly uneven with masses of fallen rock which litter it or occur as great piles of slabby stone 20 to 60 feet or more in height. The great piles of rough rock rise up in expansive rooms which are commonly connected by narrow, nearly concealed passageways. In the part known as the "Old Cave" no less than seventeen hills of fallen rock 30 to 60 feet in height occur in a distance of a little over one-half mile. The thin, slabby rock composing these great hill-like piles has fallen from the roof of the cavern, and much of the rock which now composes the roof of this part of the cavern appears unstable and ready to fall; yet there is little evidence of recently collapsed rock masses. The rooms in which the hills of fallen rock occur rise with vaulted ceilings made of the rough edges of the relatively thin strata, culminating in a broad, overhead slab of unbroken rock which forms the smooth ceiling top of the rough vault below. The largest of the rooms is "Rothrock's Grand Cathedral," which is said to be 600 feet long and more than 200 feet wide. A mountainous mass of fallen rock, known as "Monument Mountain," capped with flowstone and stalagmites rises in the room 135 feet above the base and within 35 or 40 feet of the smooth stratum which forms the ceiling of the great vaulted room. The rock-littered, uneven floor, the mountainous piles of fallen rock, the expansive rooms with vaulted ceilings, and the narrow, difficult passageways at various levels and places are the distinctive features of this multi-galleried cavern. The simple, under-

ground river courses, for ages dry, characterize a part of the cavern system, it is true; but they are little distinctive and much less impressive.

Often I look at the distinctive features of the Wyandotte cavern system and am reminded again and again that it is a cavern in ruins. Throughout a goodly part of the system its river channel characteristics are gone, and little remains to remind one of the waterways which once were magnificently present. The fallen-in condition is probably partly dependent upon the development of the younger galleries beneath the older ones, but it appears that the great rooms with their mountainous piles of fallen rock are chiefly due to the much fractured, thin-bedded strata, which, undermined in the making of the runway voids, have collapsed in weakened localities to make the vaulted rooms and the piles of slabby rock which give the cavern its most distinguished characteristics.

The three cavern pictures here attempted are based upon selected observed phenomena of three particular caverns. Comparisons are inevitable. One cavern is in vigorous youth. It is magnificent in certain of its outlines, but is yet unfinished and ugly. It is occupied by a mysterious and dangerous underground river. Another cavern is in full maturity. It is grandly made and beautiful in its finished and fully completed form. It is truly a great runway cavern whose chief characteristics clearly indicate the work of an underground river which now does not occupy the course it fashioned. The third is a complex cavern system which is undergoing a grand and admirable degeneration. Its distinctive characteristics are the magnificent ruins of a grand series of underground conduits which now show little of their former features as completed, water-made runways. Parts of this cavern system certainly present old age aspects in cavern history.