SOME FEATURES OF A SMALL CAVERN AT MARENGO, CRAWFORD COUNTY, INDIANA

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Introduction

The small, water-coursed cavern described in this paper is located immediately north of the city of Marengo, Crawford County, Indiana. The terminal opening is at the base of a bluff along Whiskey Run on the north side of the old Paoli road, just one-fifth mile west of the famous Marengo Cave. This small cavern has no name, so far as it could be ascertained, but the issuance of the underground stream is known locally as the "Old Town Spring." The water coming out here has been used for years by some of the residents of the portion of Marengo known as the "Old Town." For want of a better name, the author has christened the opening through which the water pursues its subterranean course the "Old Town Spring Cavern."

The rocks which outcrop in the immediate vicinity of Marengo are Mississippian in age, including all the formations from the St. Genevieve limestone (Meramecian) at the base to the Cypress sandstone (Chester) which caps the highest hills nearby. The St. Genevieve limestone in Indiana is the one in which most of the accessible caverns are developed. Karst valleys are often developed upon the surface where subterranean drainage is well developed. It is the water that drains into one of these valleys that pours through the cavern studied. The intermittent drainage and the swallow holes within this karst valley are shown on the map (Fig. 1). This intermittent tributary to Whiskey Run is known locally only as "the branch."

The writer is deeply grateful to Mr. William P. Von Osinski of Indiana University for his able assistance in mapping the underground route of the water, and to Dr. C. A. Malott, also of Indiana University, for his helpful suggestions.

Description of the Cavern

General.—In the ensuing pages, reference will be made to the features displayed in the cavern. For convenience, numerals and letters have been used in Fig. 1. The numerals denote points of interest, and the letters indicate cross-sections. In the text, the briefer symbols will be used and will refer to Fig. 1, unless it is otherwise stated.

The "Old Town Spring" cavern is a river cavern, through which a stream of water runs at the present time. Residents say that it never fails to flow at all times of the year. When rainfall is heavy, the cavern mouth is nearly filled with water draining from the karst valley near the head of the explored section of the cavern. The karst valley was in part developed by the surface waters when they drained into Whiskey Run through the surface channel, and indeed the flood waters which

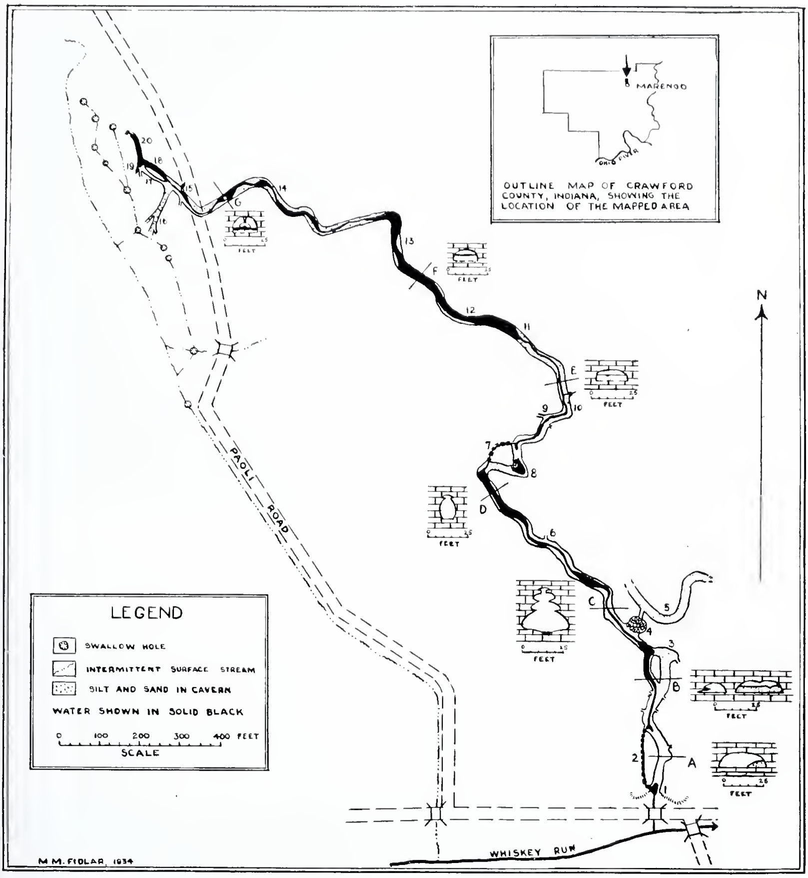

Fig. 1. Map of the "Old Town Spring" cavern at Marengo, Indiana, showing the relation of the subterranean channel to the surface drainage. Numerals and letters indicate points described in the text.

can not get into the cavern still follow this route. The subterranean passage probably originated below the water table by waters percolating through the limestone along joints and bedding planes. Later, the small, primitive, tube-like cavern was invaded and greatly enlarged by the surface waters from the swallow holes in the karst valley. That most of the enlargement has been due to vadose waters is shown by the unusually fine development of solution facets and shallow solution pits in the walls, ceiling and floor of the present cavern. These facets are developed to a greater extent in the lower portion of the cavern (see Fig. 2).

The gradient of the underground portion of the stream is very slight. Throughout the entire course of the cavern, the water falls only about three feet. This is determined by the height of the laminated zone of the St. Genevieve limestone which is shown so clearly in Fig. 2.

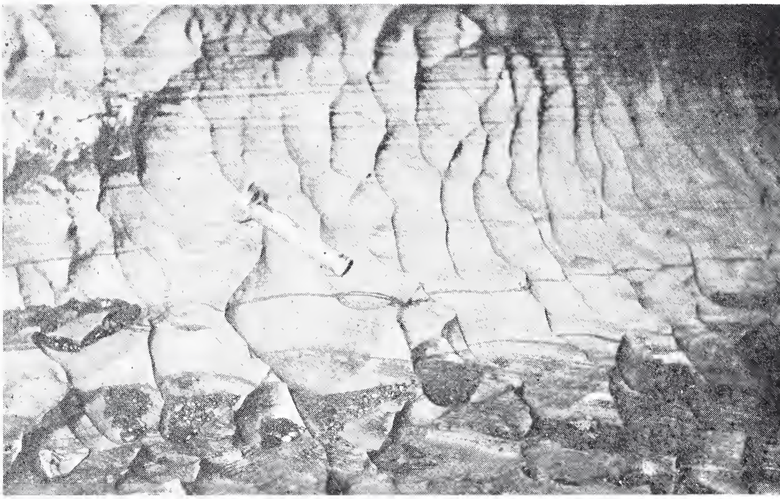

Fig. 2. View of the solution scallops on the wall and floor of the "Old Town Spring" cavern, about 800 feet from the entrance. Note the laminae in the sandy layer of the St. Genevieve limestone. Water is standing in the pits in the foreground.

This banded portion is at water level in the extreme upper end of the cavern, but at the mouth it is about three feet above the water. The general course of the cavern is along the strike of the formation. The swallow holes in the surface drainage system (Fig. 1) are developed upon a valley floor about 25 feet higher than the mouth of the cavern (Fig. 1, 1), and the holes are six to ten feet deep. As a consequence, the ceiling of the cavern in the branching portion near the upper end is separated from the karst valley floor above by only 10 to 15 feet of limestone.

The cavern is divided into four distinct portions, all possessing their respective characteristics. The lower portion, represented by the channel from 1 to 10 in Fig. 1, is approximately 1,700 feet in length. The ceiling is generally 6 to 15 feet above the water. The floor through this portion of the cavern is developed upon bedrock, sometimes thinly veneered with gravel. Wherever rock is exposed to the action of the vadose waters, facets are formed by solution. Nowhere in the remainder of the cavern are the facets so well developed. Wherever the eye falls, the walls and floor are scalloped. Even slabs of limestone lying on the floor have undergone this peculiar selective solution. In this section of the underground passage, there is little dripstone. Occasionally one comes across a small stalactite or column formed upon a high ledge above the reach of the flood waters. However, the surface of the land above is too high above the cavern to permit much percolation of the waters down into the river channel.

The second division of the cavern, shown between 10 and G in Fig. 1, is the most difficult to traverse. It is approximately 1,500 feet in length, and throughout this entire portion the water is ponded behind a heavy gravel bar developed near the lower end of the division. The ceiling is developed along a lower stratum of limestone than was the ceiling in the first division, and is either broadly faceted or smooth. There is only about one and one-half to three feet of air space between the surface of the water and the roof of the cavern. Great deposits of flocculent mud and sand mixed with an abundance of organic material cover the floor, in some places forming mud banks that nearly fill the cavern. The water above the mud is from a few inches to five feet deep. Owing to the decomposition of the organic material, such as leaves and twigs, the mud beneath the water contains great quantities of methane, or "marsh gas." In this portion of the cavern, there is no dripstone or flowstone of any type, for the flood waters fill the cavern to the roof and prevent the formation of decorative stone.

The third distinct division of the cavern extends about 300 feet, from G to 20 in Fig. 1. The ceiling is higher here, owing to a greater amount of solution overhead, and few gravel and mud bars occur on the cavern floor. At the upper end of this stretch, the cavern branches where the "feeder" tubes come into the main underground route. This portion of the cavern is very near the surface of the karst valley which sends its water through this subterranean route, and as a consequence, ornamentation is common.

The fourth division of the cavern system is the portion which it is impossible to explore. This is the more primitive portion of the cavern, consisting of tubular conduits, at or below the water table, which are filled at all times with clear groundwater.

Details.—The character of the mouth of the cavern indicated by 1 in Fig. 1 is clearly shown by the photograph (Fig. 3). The cavern mouth opens widely here at the base of the cliff and the water from it

Fig. 3. View showing the character of the mouth of the "Old Town Spring" cavern. The stream is flowing toward the camera.

enters Whiskey Run with little fall. However, for a distance of 200 feet into the cavern, the floor is dry except during times of high water. In times of ordinary rainfall, all the water in the cavern flows through the younger and shorter route (2). This normal or low-water route is very low and cannot be explored. Apparently it is a recently-formed diversion route. The floor in the older cavern is highly faceted in the dry portion, and mud banks have been formed there by deposition from the flood waters. However, a channel has been cut through the deposits so as to expose the bedrock floor of the cavern. Cross-section A shows the typical shape of the more or less abandoned portion of the cavern.

Three hundred feet from the entrance to the underground passage, a section of the older route has been almost entirely abandoned by the stream (B). Only the highest flood waters pass through the broader and larger of the alternate routes. This older portion of the cavern has been nearly sealed by a deep deposit of mud and silt. The narrow passage through which the stream normally flows is about 15 feet wide at water level and from four to five feet high. The abandoned portion is unusual in that the ceiling is composed of a double arch. This passage is about 30 feet wide and eight feet high. The older route opens into a collapsed room at 3, where flowstone and dripstone, colored with clay, are abundant.

About 50 feet upstream from 3, the stream cavern assumes a flattened cylindrical shape. The walls are roughened by solution facets. A large room, formed by the collapse of the roof (4), occurs about 430 feet from the entrance. The room is roughly circular, with a diameter of nearly 45 feet. A small passage, carved in gravels which at one time evidently blocked one side of the room, leads from this room on the north side and ends in a dry, filled cavern (5) as large as the cavern through which the stream flows. The surface of the silt and gravel fill is only two feet from the top of the cavern, but the depth to which the bedrock floor is buried is not known. The silted route was explored and mapped for a distance of 300 feet by following a small channel that has been cut into the compacted mud and gravel. Approximately 200 feet northeast of the point where the silted passage was first entered, the silt and the roof meet, and further exploration is impossible.

The main river cavern, upstream from the room of fallen rock, gradually assumes a shape different from that which has been encountered before. Harder layers of the limestone, often associated with some scattered chert, form a series of projecting ledges on the sides of the passage. Often the edges of the ledges are worn to a knife-edge. The original underground passage of the water can be seen plainly in the roof of this portion of the present cavern. This early passage consists of a tube-like route or "channel," the floor of which has been dissolved away by the vadose waters in their effort to attain their present position nearer to the water table. The side-walls and ceiling of this tube have been remarkably well preserved for several hundred feet in this portion of the cavern. The tube does not exactly parallel the center of the present cavern, but swings toward the outside when the large cavern bends one way or the other. In other words, as the cavern was enlarged by the vadose waters, there was a tendency to shorten the route through the limestone. Curves were made more abrupt and not so sweeping. At D, the marking in the ceiling is comparatively broad.

A beautiful mass of rimstone has been formed at 6, where a small tributary tube-like conduit enters the river cavern. This rimstone has been built far out into the channel through which flood waters pass, and the water in the tributary has been dammed, forming a crystal-clear pool. That anything as frail as the rimstone should have withstood the dissolving action of the waters as they flowed through the cavern is quite remarkable.

About 50 feet upstream from D, the cavern again divides, and the water under ordinary conditions flows in a shorter and younger route (7). This passage is from two to three feet wide and three feet high. The abandoned portion of the older cavern is dry except for a pool at the point where it curves sharply to the left (8). The floor of the broader passage is veneered with gravel, and at the pool of water several large blocks of rock have been broken from the wall on the inside of the curve.

At 9, large curtains of dripstone hang far down into the center of the cavern. These are suspended from the downstream edge of a dome-like opening in the ceiling, dissolved probably directly beneath a solution depression on the surface. Immediately west of this drapery stone, one gains access to a small alcove (9) by climbing up a mud bank. This was at one time apparently a tributary cavern which fed water into the main route, but it has been filled completely with gravel which has been cemented tightly subsequent to its deposition. More recent erosion by the flood waters has removed a portion of this fill for a distance of fifteen feet from the mouth of the conduit, and one stands beneath a ceiling of gravel. The immediate origin of this gravel is unknown. It is not likely that the gravels were carried to this point from the swallow holes through which water leaves the karst valley to enter the head of the underground passage. It is more likely that they came from a sink somewhere near the one which has been responsible for the draperies at this point.

At 10 a heavy gravel bar appears for the first time in the main runway of the cavern system. This bar extends from 10 to 11, and the water is confined to a small channel during low water conditions. It is this bar that has ponded the water for some 1,500 feet upstream. At 10 several ledges of limestone bring the roof abruptly down to from two to three feet above the surface of the gravel bar. The gravel bar probably owes its existence to the change in vertical dimension of the cavern at this point. Flood waters, rushing through the more restricted portion of the passage, carry the gravels to the point where the ceiling rises abruptly. The sudden decrease in velocity, due to the expansion of the cavern at this point (10), accounts for the deposition of the gravels. The bar extending to 11 has been deposited on the upstream side of the barrier at 10. The cross-section at E shows the shape and condition of the cavern in this stretch. Exploring and mapping become exceedingly difficult upstream from 10, since one must walk in a stooped position almost continuously for 1,500 feet. The ceiling beyond this gravel bar is typically a corrasion ceiling, indicating that the water must completely fill this portion of the cavern following heavy rains. The worn ceiling is flatly arched and unusually smooth.

The corraded ceiling extends to 12, where it changes gradually into a rough, slightly faceted surface. This was at one time evidently a broadly-faceted ceiling with sharp horns and ridges between the hollows, but erosion and solution have partially effaced these features and have subdued all angles. At 12, a peculiar situation prevails. It is a general rule that water on the outside of a curve in a stream channel is deeper than that on the inside, owing to the greater amount of deposition on the inside where the velocity of the water is somewhat checked. At this point, the water is far deeper on the inside of the bend, and it is necessary to hug the outer wall in order to pass this point without swimming, even when low water conditions prevail.

The subdued facets on the ceiling persist as far as 13, where the flat, smooth, corraded type of roof appears again. The latter type continues halfway to 14, then the facets begin to appear again. At 14, a small tube is seen in the center of the cavern roof, and from it is appended a broad stalactite, curved slightly in a downstream direction near the lower end. The hole, from which issued the waters which formed this stalactite, faces upstream. Dr. Malott, upon seeing this feature for the first time, very aptly named it the "Lion's Mouth." A few feet upstream, the cavern passage again assumes a height sufficient to allow one to stand erect.

The cross-section G shows one of the most interesting ornamental features of the cavern. This is a bell-shaped mass of flowstone suspended in the center of the passage by a stalactitic column growing from the middle of the ceiling (Fig. 4). The lower edges of the flowstone just touch the surface of the water during low water conditions. So far as

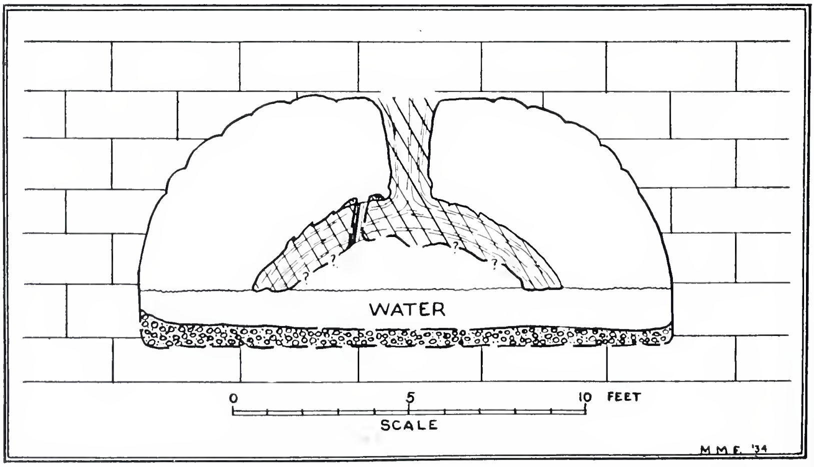

Fig. 4. Diagrammatic cross-section of the cavern at G, Fig. 1, showing the character of the flat flowstone cone suspended from the ceiling. Note the hole and the low mud cone around its upper end.

the writer could ascertain, this bell-shaped formation is hollowed out to some extent on the inside, and does not rest at any place upon the gravel which veneers the floor. However, the cavern at this point shows unmistakable signs of having been filled several feet above the bedrock floor at some time during its development. The flowstone mass was probably built upon a higher portion of the gravel bar. Subsequent erosion has removed the gravel and has left the flowstone suspended above the water. The surface of this feature is indented in several places by pits surrounded by low walls of rimstone. In one place, a hole pierces the entire thickness of flowstone (Fig. 4). A small, low cone of mud has been formed at the mouth of this hole. The writer is unable to explain this phenomenon, but it is certainly associated with muddy flood waters in the cavern.

The main subterranean passage begins to branch into its many tributaries about 150 feet upstream from the flowstone described above. At 15, great deposits of flowstone have been formed, reaching from the floor of the cavern to the ceiling 12 feet overhead. The small tube entering on the north side of the passage, which has been responsible for the most massive accumulation of flowstone, enters the side of the cavern near the roof, and the stream of water which flows in the tube even during dry seasons falls behind the flowstone mass and enters the main stream channel at floor level. Just upstream from this point, there is some good evidence that this portion of the cavern was at one time partially filled with gravels. Here a flowstone accumulation projects into the passage from the north side as a ledge, the bottom of which, four and one-half feet above the bedrock floor of the cavern, is covered with the coarse cemented gravels that are so characteristic elsewhere in the underground route. This undermined cone of flowstone was probably formed upon the surface of the flat gravel fill during some earlier stage of development, and the detrital material has since been removed from beneath it.

The largest of the tributary passages leading from the main stream route is the one indicated by 16. This cavern is six feet wide in the lower portion, and is partially filled with coarse rubble composed of gravels from the surface and blocks collapsed from the ceiling. Several small conduits of a tube-like nature enter this tributary from each side, several of which were explored but not mapped, owing to the lack of room. A strong draft in this portion of the cavern indicates that it has a direct connection with the swallow holes in the floor of the karst valley on the surface. Roots can be seen penetrating the cavern through the joints and bedding planes of the rock. In one instance, the exploring party noticed a small root hanging from the end of a stalactite. Upon examination it was found that the dripstone has been built about the root, which seemed to serve as a nucleus around which the calcium carbonate was deposited. At the lower end of the passage (16), cars can be heard passing overhead upon the Paoli road. Certainly the roof of this portion of the cavern is separated from the surface of the karst valley by only 10 to 15 feet of St. Genevieve limestone.

A fourth instance of underground diversion is noted where the waters have abandoned their older passage (17) and have taken to a newer route (18). The abandoned passage is filled with rimstone to such a depth that progress through this route can be made only by crawling over the sharp edges of the calcareous rims which form the basins where the water at one time collected, The newer channel (18) is rather restricted in the upper half, where the ceiling is only a little over one foot above the surface of the waist-deep water.

The two passages described above converge at 19 and form a room 30 feet in diameter, into which enter two restricted tube-like conduits and the larger passage, designated as 20 on Fig. 1. This last division of the cavern is quite narrow and low, but it seems to be the principal route by which water is fed into the "Old Town Spring" cavern from the surface.

Some children of the neighborhood report that egress from the cavern has been made through a hole which opens to the surface in the bottom of a swallow hole depression. The writer could find no such opening. However, there is a strong current of air in several of the tubes which drain the swallow-holes in the karst valley above, but it is probable that the holes are filled to a great extent with debris. The writer and his associates found tin cans, dolls' heads, old shoes and like debris in the gravels toward the head of the passage numbered 16, so the holes through which the surface water sinks to its lower level must be large enough to admit such objects as these.

Summary and Conclusion

The "Old Town Spring" cavern at Marengo, Indiana, exhibits many interesting features intimately connected with the development of caverns in limestone regions. The explored portion of the cavern system can be divided into three distinct divisions, each with its particular characteristics. The lower portion of the cavern is characterized by a comparatively high ceiling, rock floor with few gravel and mud deposits, three diversion routes which the low-water stream follows, little ornamentation, and an abundance of solution facets on every surface of limestone exposed to the action of the vadose waters. The middle division of the cavern is characterized by the comparatively low ceiling which shows unmistakable signs of corrasion, the water ponded behind the heavy gravel bar at the lower end of the division, total lack of ornamental stone, and the heavy deposits of mud both above and below the surface of the water. The upper division of the underground passage is characterized by the rock floor, the great amount of flowstone and dripstone, the relatively high ceiling, and the anastomosing and branching tributaries through which the waters from the karst valley above reach the main cavern passage.

The presence or absence of dripstone and flowstone seems to be due in part, at least, to the thickness of the limestone which separates the roof of the cavern from the surface of the land above. Accordingly, the lower division does not have much dripstone, except quite near the mouth. The middle division, which is farthest underground, has no ornamental stone whatsoever, although this fact may also be due in part to the fact that the waters fill this portion of the cavern to the roof in times of heavy rainfall. The upper division of the cavern is developed only 15 feet or slightly more beneath the surface of the karst valley above, and as a result, there are great deposits of both dripstone and flowstone. Rimstone has also been extensively developed in this portion of the cavern.

The development of caverns similar to the one described in this paper seems to be divided into two stages: the formation of primitive, tube-like or flat routes of movement through solution of the limestone by percolating waters below the water table; and the invasion and further development of these early passages by vadose waters, after the water table has fallen below the primitive channels of movement. In the early stages, the percolating groundwater has more opportunity for solution of the limestone along the bedding planes and joints, since movement of water within the rock itself is certainly so slow that the effects of solution could not be readily discerned. An anastomosing network of channels is surely formed by the groundwater in this manner. When the land is elevated, the water table falls below the series of interlacing routes, and the vadose waters from the surface begin to invade these primitive conduits, in their attempt to reach the level of the water table. It is the vadose waters that are probably responsible for the greater part of the solution that accompanies the development of river caverns in limestone regions. The floor of the primitive tubes is first attacked, and gradually the water works its way downward.

A few features in the "Old Town Spring" cavern seem to add to the evidence in favor of such a theory of development as the one outlined above. The primitive stage is represented by the tubular marking in the ceiling through several hundred feet of the lower portion of the cavern. The sides and top of this primitive conduit have been well-preserved, but the vadose waters which invaded the cavern system in the later stage have developed a wide cavern opening below this primitive route, as they sank toward the water table. This tubular primitive route of water movement is slightly longer than the present channel. Another portion of the cavern system that is also primitive is the extension of the channel designated in Fig. 1 by 20. This portion beyond the explored stretches of the cavern was not followed for any great distance because of the fact that the route was nearly filled with water during low water conditions. This, then, is a more or less primitive portion, at or near the water table, and undoubtedly the upper part of it would illustrate the type of passage formed by the percolating ground water, were it accessible. The explored portion of this cavern system has been formed by the vadose waters which invaded the primitive cavern system from the karst valley. This postulation is given support by the great height of the passage, as contrasted with the small, low passages through which waters below the water table would flow. Further, the solution facets, which occur in such profusion in the lower part of the cavern, have been formed by the invading surface waters as they developed the cavern system.

The several diversion routes which the waters follow in this small cavern indicate a tendency to shorten the route through which the surface waters pass underground. These diversion passages are all apparently younger than the larger portion of the cavern, although they may have originated as pasages formed below the water table, and were invaded only after the vadose waters had reduced the floor of the cavern to a level sufficiently low to allow the waters to pass through them.

The cavern described presents evidence in a few places that it was at one time partially filled with gravels above the bedrock floor. At present, there is some filling in the middle division, but the evidence of former filling is found in the upper division. At G, the large flowstone cone was probably deposited upon a gravel fill, which has subsequently been removed to a great extent, and this ornamental feature now is suspended by a column from the ceiling above the thinly-venecred floor of the cavern. Near 15, a flowstone deposit forms a projecting ledge, the bottom of which is coated with cemented gravels. This was probably also deposited upon a gravel fill, the surface of which stood at least four and one-half feet above the present bedrock floor of the cavern. Dr. Malott states[1] that he has never seen a cavern in which a river is running which did not present some evidence that it had at one time been filled to some extent.

The "Old Town Spring" cavern is a fine example of a cavern developed under the control of joints in limestone. The dip of the strata in this region is toward the southwest. Fig. 1 shows that the principal trend of the cavern is in a northwest and southeast direction, or along the strike of the rocks. It can be seen that the strike joints in the St. Genevieve limestone played the most important part in the development of this route, although the dip joints also directed the flow of the waters in a northeast and southwest direction. In the upper part of the cavern the water follows joints in an up-dip direction, while farther along the down-dip direction is followed. The mean position is almost exactly parallel with the strike joints. The cavern, it may be noted, is in places so widely developed that little relation of the direction may be apparent. This is characteristic of caverns which have passed their earlier stages of development.

[1] Personal communication.