The Survey of Blue Spring Cave
Lawrence Co., Indiana

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Abstract

Blue Spring Cave, with 18.8 miles of surveyed passage, is the longest cave in Indiana and sixth longest in the world. Results of a compass-and-tape survey show that the cave is the conduit for a ground-water flow system draining about ten square miles of the Mitchell Plain southwest of Bedford, Indiana, and discharging at Blue Spring on the East Fork of White River. The maximum observed discharge in the main stream is 300,000 g.p.m. Little correlation exists between cave passage and surface sinkholes, except where collapse sinkholes have developed in areas of widespread passage breakdown. Most sinkholes and sinkhole ponds appear to contribute water to the cave system through narrow lateral joints and fissures. Some sinkhole ponds are located directly over air-filled cave passages. The cave developed in three distinct levels, as the East Fork of White River became entrenched into the Mitchell Plain, with a possible fourth level existing below present base level.

Blue Spring Cave, located four miles southwest of Bedford, Indiana, contains a total of 18.8 miles of surveyed passages. Comparison with survey figures for other caves shows it to be the longest cave in Indiana and sixth longest in the world.

The cave is developed in the upper Salem Limestone and basal St. Louis Limestone of Middle Mississippian age. The entrance is one mile west of Hartleyville on the George Colglazier farm in a collapse sinkhole in the St. Louis Limestone. The cave is a conduit for a dendritic ground-water flow system draining about ten square miles of the Mitchell sinkhole plain and discharging at Blue Spring on the East Fork of White River.

Prior to 1964, the known part of the cave consisted of only a two-mile segment of the main stream passage. Penetration downstream was halted at a point where the water touched the ceiling, and upstream progress was limited by low, wet crawlways. Between January and October, 1964, four major discoveries of several miles each were made in the upstream direction by a group of Indiana University students. The known length of the main passage was doubled, and numerous tributary stream passages and dry, upper levels were found. Additional discoveries continued to be made throughout the following three years while the cave was being mapped.

The survey of the cave was initiated by the author in June, 1964, and completed in August, 1967, in conjunction with field work for a Ph.D. dissertation in karst hydrology at Indiana University. A mounted Brunton compass and tape were used to obtain the survey line, and sketches and cross sections were made of the passages to provide detail for the map. The average error on closed survey loops was about 0.5%. Elevations were inferred from stratigraphic data and from several water wells which pentrate the cave. The mapping of the cave required

41 trips of between 8 and 18 continuous hours each, involving a total of about 1500 man-hours. The survey notes were plotted on the standard scale for large caves, 100 ft./in., which resulted in a map twelve feet long and six feet wide. This map was later reduced to topographic-map scale for convenience and for geomorphic analysis (Figure 1).

Several significant hydrologic and geomorphic observations can be made from the map. The dendritic stream pattern has been masked by

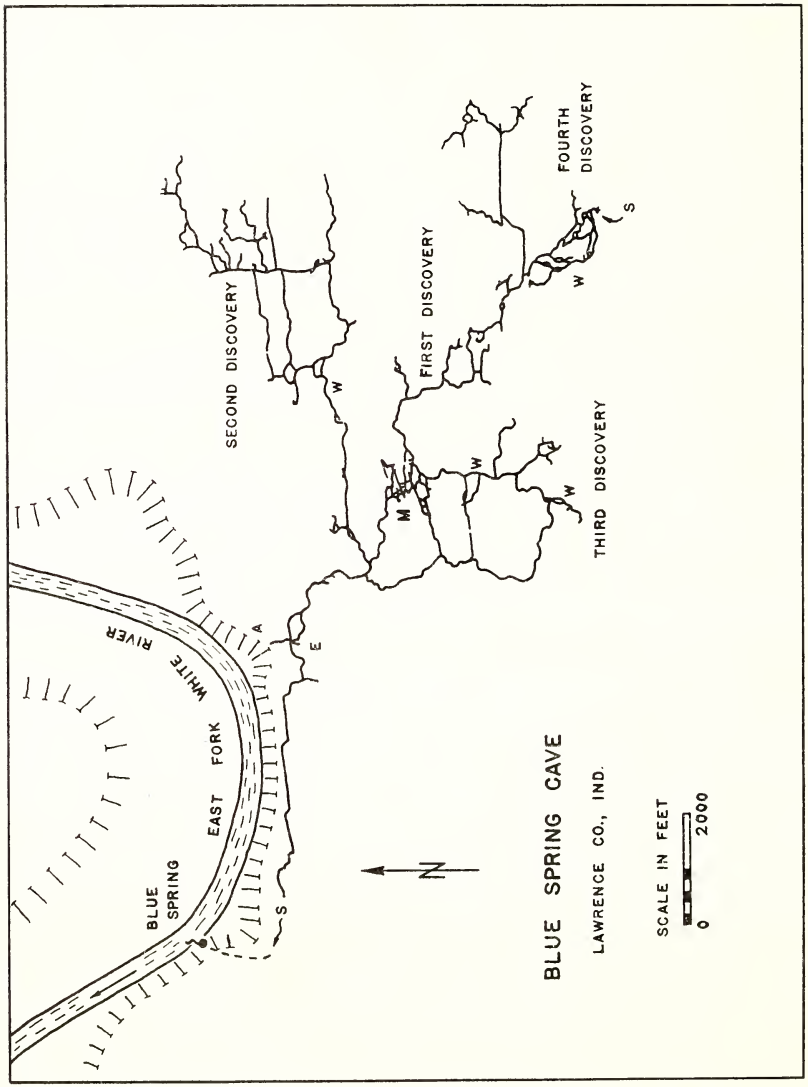

Figure 1. Map of Blue Spring Cave, Indiana; E. entrance; S-S: course of main stream through cave; M: Maze; A: abandoned spring alcove; W: waterfalls.

numerous piracies and diversions, mainly the result of passage collapse. Apparently breakdown of the type that produces collapse sinkholes is impermeable enough that in most cases a subsurface stream will be diverted around the breakdown, enlarging nearby joints by solution under pressure rather than continuing to flow through the breakdown. As an example, collapse midway in the main stream passage has resulted in the formation of the Maze, a complex diversion system of joint-controlled passages (Figure 1, M). Except for a few large collapse sinkholes, there is very little apparent correlation between passages in the cave and sinkholes on the surface. Most sinkholes appear to be sources of water to the cave by way of minor joints and fissures which connect with the main passages. Several sinkhole ponds lie directly over passages in the cave and contribute a small, perennial trickle of water to the cave.

The profile of the cave shows a dual-stage development of the present stream course (Figure 2A, *2* and *3*). The main stream and its tributaries are presently cutting headward at waterfalls, whose distance from the spring is proportional to the stream discharge in each passage (Figure 1, W). The amount of downcutting at the waterfalls is consistently about fifteen feet throughout the cave. Above the waterfalls the average passage gradient is between 50 and 100 feet/mile, whereas below the waterfalls the average passage gradient is between 10 and 20 feet/mile. The actual stream gradient in the downstream part of the cave is as low as 5 feet/mile. This low gradient is the result of alluviation of the river valley by 85 feet of glacial outwash and the ponding of the river by the Williams dam, 10 miles downstream from Blue Spring, which has totally flooded the lower half-mile of the main stream passage. The dip of the rocks is about 30 feet/mile to the southwest, and the cave drops progressively lower stratigraphically in the upstream sections, but trends stratigraphically upward in the downstream sections. The lowest stratigraphic points in the cave are about midway between the furthest exploration upstream and the spring exit.

Below the waterfalls, many of the major passages in the cave have cross sections which reflect the downcutting of the stream to the lower level (Figure 2 B, a). In other cases the lower level is distinct from the upper level as the result of diversion, rather than downcutting, which has created dry, upper levels, most of which are in the St. Louis Limestone (Figure 2 B, b and c). Certain passages are developed along major joints in the Salem Limestone, and the resulting cross section is that of a high, narrow fissure (Figure 2 B, d).

At elevations higher than either of the above-mentioned levels, remnants of a still higher level may be seen in discontinuous segments terminated by breakdown and clay fill (Figure 2 A, *1*). Dripstone formations are numerous in this level of the cave.

There is evidence for a fourth level below the present stream levels (Figure 2 A, *4*). A small pool in the Maze has been found to be 28 feet deep and the source for a small stream which flows into the main passage. The pool is only one foot in diameter at the top, but increases in diameter with depth. It is possible that this is an outlet for a cave

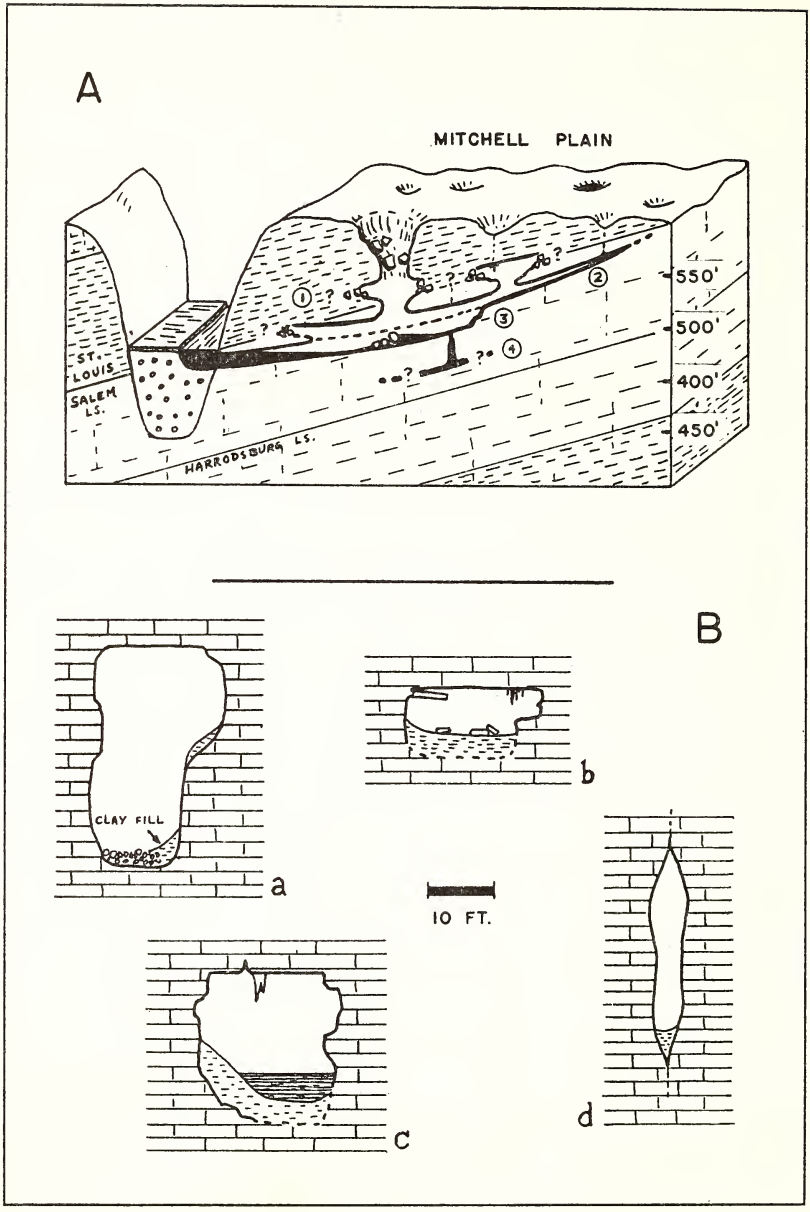

Figure 2

A. Idealized block diagram through the main stream passage of Blue Spring Cave, showing relationship of the four major levels of development to the geology and topography.

B. Representative passage cross sections. a: Main stream passage above Maze, showing dual-level development. b: A dry upper level in St. Louis Limestone. c: Main stream passage below entrance, showing lower level in Salem Limstone. d: A typical joint-controlled passage.

level developed prior to alluviation of the river valley and subsequently flooded.

The main stream passage (Figures 1, S-S) carries a low flow in summer and fall of about 500 g.p.m. and an observed peak flow of 300,000 g.p.m. during a period of combined snow melt and heavy rainfall. Discharge figures were obtained with a type AA rod flow meter.

The development of the cave has been controlled by the downcutting of the East Fork of White River into the Mitchell Plain. Cave levels appear to have formed at grade with temporary base levels provided by pauses in downcutting. Dissection of the Mitchell Plain provided enough local relief to cause subsurface drainage to be established by underground diversion of streams and by development of solution channels by ground water at the level of the water table. Major pauses in downcutting occurred when the river was at elevations of about 70, 110, and 125 feet below the Mitchell Plain surface, with the result that the three main cave levels were developed approximately at grade with these elevations. The fourth and lowest level apparently formed at a time when the river was at a deeper stage than at present. The fact that the third level is actively forming today suggests that it may be more recent than the lowest level. In this case the third level would be forming in response to the change in base level caused by alluvial filling of the valley.

Throughout the solutional enlargement of the cave, collapse has been an important process in controlling the pattern of ground-water flow, passage morphology, and surface karst features. The uppermost level has already been truncated by collapse to the extent that its original dendritic pattern has been obscured, and today this process is also acting upon the lower levels. The development of Blue Spring Cave is apparently an important phase in the solutional lowering of the limestone surface.