

CAVES OF THE KINKAID LIMESTONE NEAR — COBDEN, ILLINOIS

STANLEY E. HARRIS, JR., and BILL DEAN ALLEN
Southern Illinois University, Carbondale

Numerous caves are known in the outcrop area of Mississippian limestone which extends across the southern counties of Illinois. Most of the caves are only of moderate size and are not spectacular from the commercial point of view. However, they are of considerable geologic interest. A few of the larger caves such as Cave Hill Cave and Cave-in-Rock Cave have been described in the geologic literature.¹ Our study concerns five caves in the Kinkaid limestone in a small area near Cobden, Union County, Illinois.

The Cobden area is shown on the accompanying map (fig. 1). It is within the Shawnee Hills section of the Low Interior Plateau physiographic province. The northern margin of the province marks the southern boundary of advance by the Illinoian glacier. This glacier almost reached the Cobden area and actually dammed the north-flowing streams and caused a temporary reversal of flow.

TOPOGRAPHY

The topographic map of the area (fig. 2) shows a mature region of hills and valleys. The relief is on the order of 200 to 300 feet. Very little

¹ Bretz, J. Harlan, Vadose and phreatic features of limestone caves: *Jour. Geol.*, vol. 50, pp. 752, 757, 758, 1942.

flat upland remains, and little flood plain exists along the valley bottoms.

The topographic divide is a prominent south-facing escarpment trending east-west across the area. The north-flowing streams rise close to the margin of the escarpment. They flow parallel to each other, and have a dendritic pattern of tributaries. Most of the south-flowing streams have steep headwaters rising on the escarpment face, but a few have breached the escarpment. These have captured the headwaters of north-flowing streams, and their deeply dissected valleys have cut off outliers, such as Buck Knob.

The escarpment face is divided into two bluffs by a terrace-like bench. The bluffs are formed by massive sandstones and the bench is caused by the intervening weak Kinkaid limestone. Actually much of the bench is underlain by the *Degonia* sandstone stripped of the limestone cover.

Line AB on figure 2 shows the location of a cross-section profile (fig. 3) drawn from Drury Creek valley southward across the escarpment. Here we see Wing Hill as the dominant upper bluff, the bench, and the lower bluff. The gentle northward dip of the rocks controls back-slope topography. Guthrie Cave is low and accordant to the Drury

Creek Valley; Rich's Cave is somewhat higher but also on the back-slope; and Cobden Cave is high on the escarpment face.

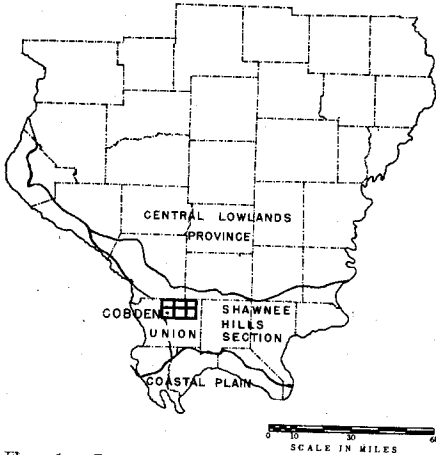


FIG. 1.—Location of Cobden area, Union County, Illinois.

STRUCTURE

The regional dip of the rocks is toward the north at an angle of 1 to 2 degrees with some modifications of direction and angle by local structures. Structure maps of the area have been drawn by St. Clair² and Lamar³.

STRATIGRAPHY

The geologic map of the Carbonate quadrangle by Lamar⁴ covers most of the area under consideration, except for a portion of the Alto Pass quadrangle. That area has been mapped by J. M. Weller and G. E. Ekblaw.⁵ The outcropping rocks

are the uppermost units of the Mississippian Chester series and the Pennsylvanian Pottsville series. The units significant to our study are the Degonia sandstone and the Kinkaid limestone in which the caves occur, both of Chester age, and the Pennsylvanian Lick Creek sandstone and conglomerate.

The Degonia sandstone is a massive cliff-forming formation from 75 to 125 feet thick in the region of study. It forms the lower of the two cliffs which cap the escarpment. The sandstone is composed of clean white fine to medium-grained, angular sand. Absence of pebbles distinguishes it from the younger Lick Creek sandstone. Typically the natural exposure is weathered grayish buff, and the ledges are covered with lichens. Thin shales are intercalated in the upper portion, and the lower portion is transitional into the underlying shales and limestones of the Clore formation. The middle portion of the Degonia is the prominent massive member.

The Degonia has a broad outcrop distribution. It not only forms the prominent scarp but much of the bench and the southern part of the back-slope of the escarpment. A broad area north of Cobden is immediately underlain by the sandstone with only a thin cover of loess.

The Kinkaid limestone is significant as the soluble host to the caves of the study. The formation is reported to be 140 feet thick at the eastern extremity of the area near Lick Creek and Lilly Cave, but thins progressively, though apparently irregularly, toward the west. The variation in thickness is due to pre-Pennsylvanian erosion, which com-

² St. Clair, Stuart, Oil investigations in parts of Williamson, Union and Jackson counties: Illinois Geol. Survey Bull. 35, p. 50, 1917.

³ Lamar, J. E., Geology and mineral resources of the Carbonate quadrangle: Illinois Geol. Survey Bull. 48, pp. 133-140, 1925.

⁴ *Op. cit.*

⁵ Weller, J. M., and Ekblaw, G. E., Preliminary geologic map of parts of the Alto Pass, Jonesboro, and Thebes quadrangles: Illinois Geol. Survey Rept. Inv. 70, 1940.

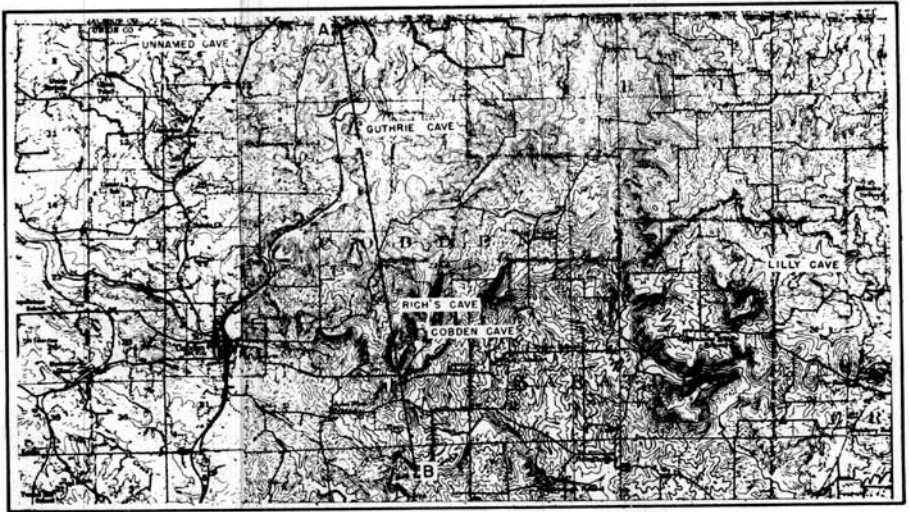


FIG. 2.—Topographic map of the Cobden area showing cave locations.

pletely removed the limestone from the Alto Pass area. The Kinkaid limestone rests conformably on the Degonia formation.

The Kinkaid formation is composed dominantly of limestone ranging in texture from lithographic to coarse-grained calcarenite, and in color from light brown to buff, bluish gray, dark gray or nearly black. It weathers to pale gray or yellowish brown. Irregular, flattened chert masses occur at certain horizons. Well-bedded chert layers occur in a few places, such as in the roof near the entrance of Cobden Cave. The chert is dark brown to black, commonly mottled by lighter-colored crinoid and other fossil fragments. A siliceous limestone is exposed in Cobden Cave. Here the carbonate has been dissolved, leaving spongy projections which are easily broken by a hammer blow. Most of the purer limestone is very dense and difficult to break. Fossils are common.

Shale and shaly limestone are common in the formation but are seldom well exposed. A few shaly beds occur near the entrance to the caves and several very shaly layers are exposed near the roof of Guthrie Cave. Eight feet of thin-bedded gray and pinkish clay shales were noted about 50 feet below the base of the Pennsylvanian conglomerates in an undercut slope on Drury Creek in the middle of section 16 T. 11 S., R. 1 W.

The Kinkaid limestone has a broad distribution only where it is thick near Lilly Cave and on the bench along the headwaters of the creek which flows into Little Grassy Lake. It occurs in the lower slopes beneath the resistant cliff-forming Pennsylvanian sandstones which form the highest ridges and knobs of the back-slope of the escarpment. The limestone occurs in steep slopes along Drury Creek and apparently caps some of the low hills west of the creek. In the Alto Pass quadrangle the limestone apparently is broadly

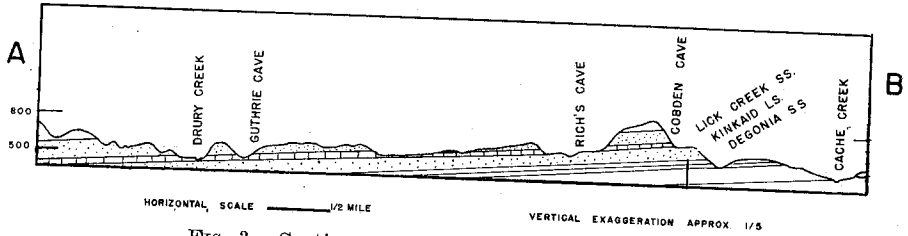


FIG. 3.—Section across the Cobden escarpment.

distributed on the backslope of the escarpment and northward along Mill Creek almost to Jackson County line. It is marked throughout its distribution by development of sink holes.

Three Pennsylvanian formations occur in the area. Of these, only the lowermost Lick Creek sandstone and conglomerate are significant to this study. The overlying Drury shales and Makanda sandstone are present near the escarpment only on the higher ridges such as Wing Hill in sec. 27, T. 11 S., R. 1 W. The Makanda sandstone is the dominant rock a few miles to the north.

The Lick Creek sandstone is typically a medium- to coarse-grained, massive, white sandstone which weathers to a buff color. Throughout the area of this study irregular conglomerate beds of white quartz pebbles are present.

This formation forms the higher portion of the escarpment proper or may form a second rise some distance away from the lower Degonia bluff. Cobbles derived from it are found abundantly in all the creeks, and in the caves.

Loess of Pleistocene age rather generally mantles the region. It has been eroded from the steepest slopes but has accumulated to a depth of several feet on the lowlands. It caps the uplands and is the parent

material of modern soils. It has significance in this study because it is the source of the silt which forms part of the fill in the caves.

Terrace deposits occur in the valleys but are not important to the present study.

THE CAVES

The topographic positions of the five caves are shown on figure 2.

- (a) Guthrie Cave is at the northern limit of the limestone outcrop on Drury Creek, and the mouth is accordant to the valley floor.
- (b) An unnamed cave (now called Union Point Cave) is near the northern extremity of the limestone outcrop on Mill Creek, but like
- (c) Rich's Cave occurs low in the valley. The streams which emerge from them cascade several feet to the valley bottom.
- (d) Cobden and Lilly Caves occur high on the south-facing escarpment and do not seem to be related to the adjacent valleys.

Rich's cave has a large mouth with a flat roof and a prominent cascade from mouth to stream. There are also two known entrances through sink holes. The only known openings to Cobden and Lilly Caves are through

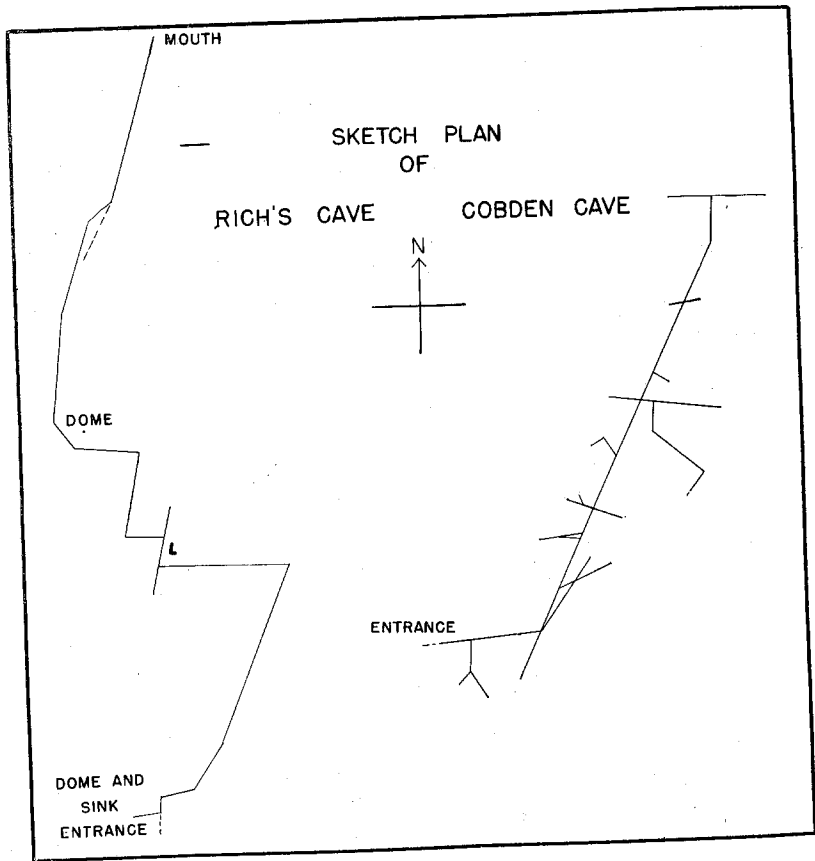


FIG. 4.

sink holes; the entrance to the latter is actually through a joint in the base of the Lick Creek sandstone.

All of the caves investigated are developed in the Kinkaid limestone. Other caves in the lower Chester and Meramec limestones are known and have been entered by the authors but are not here discussed. Cave Hill Cave in Gallatin County, best known of southern Illinois Caves is also in the Kinkaid limestone.

It is interesting that most of these caves have formed close beneath the Pennsylvanian Sandstone contact. The only exception appears to be

Rich's Cave. The stratigraphic position within the Kinkaid itself is not constant, however, because the post-Mississippian erosional unconformity beveled the formation. Whereas Lilly Cave must occur in uppermost Kinkaid, Guthrie, and Union Point caves must be in the lower portion of the formation.

Solution work has been controlled by the jointing of the limestone. In the two caves which have been mapped (fig. 4) three principal joint sets and several minor joint sets are developed. The joints trending N. 25° E., N. 85° E., and N. 15° W. are domi-

nant in Rich's and Cobden caves. These caves are representative of the two basic patterns of cave development. Rich's Cave is a longitudinal cave with a single passage which turns sharply from one joint system to another. A few detritus-filled passages do occur in this cave. The general trend is down the dip of the rocks. Guthrie Cave has two tributary streams joining the main passage. Cobden Cave (also shown in fig. 4) has a network pattern, although the open passage is now longitudinal. The original solution cavern appears to have been an intricate network of connected passages developed along three main joint sets. Lilly Cave is a particularly striking example of a network cave developed

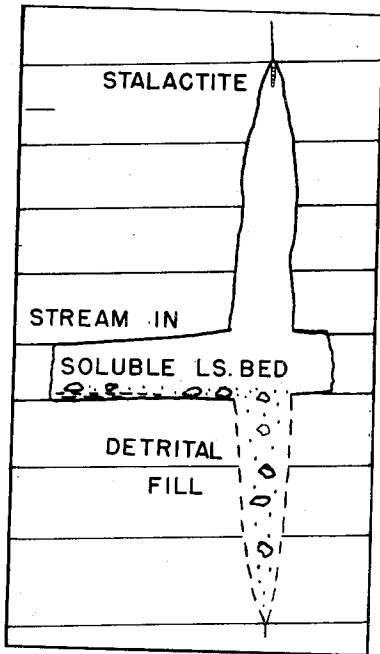


FIG. 5.—Diagrammatic representation of solution work in a part of Rich's Cave, Union County, Illinois.

along two sets of joints crossing nearly at right angles.

Solution has been localized along the nearly vertical joint planes. Commonly solution work has been dominant in a certain bed and hence widening has occurred there. The inner portion of Rich's Cave is a narrow slot tapering upward to a peak, or a dripstone fill (fig. 5). The floor here is covered by rubble, and hence the lower portion of the profile is uncertain. However, deep holes where the stream crosses the slot suggests a floor profile similar to that of the roof. In Rich's, as in the other caves, the broadest portion of the caves is almost invariably a dense, light gray, sublithographic limestone. Adjacent coarser crystalline limestones and even siliceous horizons (notably in Cobden Cave) have also been dissolved. In some caves the roof is a flat resistant bed of relatively insoluble rock. The flat roof at Cobden Cave (fig. 6) is a bed of chert in the entrance passage, and a very siliceous horizon beyond that. Here the joint is generally visible in the roof but commonly opens out only in small ceiling cavities. Ceiling and wall cavities developed along joints in all caves. They extend outward from the main passage only a short distance and then come to a dead end. There is no evidence that water entered the cavity except from the cavern itself.

Domes rise above the main passage in Rich's, Guthrie, and Union Point caves. In each case the dome leads to a sink hole. The joints have been enlarged by percolating water. Vertical solution has grooved the walls. Dripstone and flowstone occur along

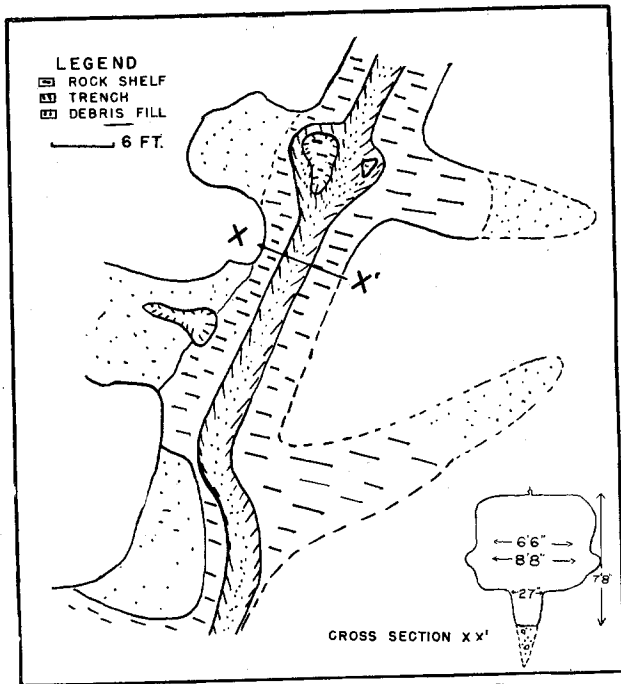


FIG. 6.—Plan of portion of Cobden Cave.

with solution features in the same dome.

A second level is well developed in a part of Guthrie Cave. It follows the same joint as the lower stream-filled passage, and an open slot connects the two. Dripstone fills the roof cavity of the upper level. Rich's Cave also has an upper passage, but it has not been investigated thoroughly by the authors. Gray clay from the shaly limestone makes progress difficult. It, too, has a central floor slot connecting to the lower passage.

Tubular openings occur in Rich's, Guthrie, and Cobden caves. Each has developed along a joint and now has a flow of water through it. Each tube is apparently being actively enlarged and appears much younger in

development than the main cave. The tubes in Guthrie and Cobden caves are too small to enter. The one in Cobden Cave carries a tributary flow of water, apparently from a sink hole; in Guthrie Cave the main flow of water leaves the traversable cave passage through a small tube and then rejoins it some distance beyond.

The tubular passage in Rich's Cave is markedly different from the rest of the cave, and appears to be of relatively recent origin. The passage occurs in a dense blue limestone. It is about 125 feet long and has an oval cross section about $2\frac{1}{2}$ to 3 feet high; it is somewhat wider than high. The controlling joint is obscurely visible, though no ceiling slot has developed along it. Some cross joints are slightly enlarged, and, in

wet weather, one carries a small stream of water.

The tube shows every evidence of active enlargement. The floor, walls, and ceiling are smooth and dense and extensively fluted. The floor is generally covered by several inches of sand, but on several occasions the writers have crawled across the nearly bare, fluted floor. Twigs and grass on the roof are evidence that the passage is sometimes entirely filled by water.

The passages at each end of the tube are broader and higher, have a flat roof, and apparently do not fill completely with water. The tube follows a joint intersecting these passages at a sharp angle. Furthermore, close to the intersection at each end of the tube, there is a rubble-filled opening which probably marks the former passageway.

Anastomosis is described by Bretz as a "multitude of small, sinuous passages along a bedding plane, the earliest attempt at caving-making in a formation."⁶ Such small interconnected passageways are well developed along the wall and in some of the ceiling blocks in Rich's Cave. They are clearly the work of solution. Bretz suggests that they form under phreatic conditions but it occurs to the authors that they might also form beneath the surface of a water-table stream or at times when the cave is full of water. Ample evidence that these caves are sometimes filled with water includes the presence of small sticks, leaves, and sand on near-ceiling ledges, fluting high on the walls and (in the case of Rich's tubular passage) on the ceiling itself.

⁶ Bretz, J Harlan, Vadose and phreatic features of limestone caves: Jour. Geol. vol. 50, p. 706, 1942.

Complete rock spans have not been observed in the passages of these caves although they are well developed in the Sensemeyer Cave in Meramec limestone below the escarpment. However, a well-developed partial rock span occurs in Cobden Cave. A narrow partition of undissolved limestone hangs from the ceiling for a distance of about 10 feet. It is only 6 inches to a foot thick but hangs down about 3 feet from the roof. It is rough and weathered like the walls and shows no evidence of recent contact with a body of water. It is difficult to visualize the formation of such a partition except by solution work at a time when water surrounded the partition itself.

Vertical grooving caused by the solvent action of water flowing over the surface of the limestone has already been mentioned in connection with the domes. Similar parallel groovings occur along ledges which normally stand above the modern subterranean stream. They are recent features and may be formed by the sheet-like flow of water which moves down the walls in some parts of these caves.

Flutings are a series of cupped depressions very much like ripple marks. However, they are solution features in the limestone. The steep face is on the up-current side of the cup and the gentle slope on the down-current side. These apparently retreat upstream as the result of more rapid solution because of turbulence below the steep face. The flutings are well developed and active today in the fine-grained blue limestone in Rich's and Guthrie caves. They occur only where the stream covers the surface.

DEPOSITION.

Secondary carbonate deposits are abundant only in Lilly Cave. Rich's Cave has a few small stalactites actively growing today in the passages adjacent to room L (fig. 4). In room L there is a large column about 2 feet in diameter and many stalactites which have formed along the major roof joint. Near the mouth of Guthrie Cave the roof is covered by a multitude of slender stalactites one to three inches long and apparently growing. Only some 100 feet or so inside the cave conditions for precipitation are not favorable and dripstone and flowstone are found only at the domes or along roof joints where considerable water enters.

Lilly Cave is essentially dry today and no water enters the joints. However, great masses of stalactites, stalagmites, columns, and flowstone occur in the passages. Some passages are blocked by this secondary material. In the passages near the ground surface there are crusts of flowstone interbedded with silt deposits. Some crusts are several inches thick. Similar flowstone has developed in the Cave Hill Cave in Saline County.

Crystals of calcite form a veneer over the roof and walls of part of Lilly Cave. The calcite crystals are mostly small (less than $\frac{1}{8}$ inch in length) but form a complete sheath $\frac{1}{8}$ to $\frac{1}{4}$ inch thick. The crystals are clear to buff, containing some silt. We have not investigated to see if the crystals extend downward between wall and detrital fill.

All the caves contain detritus. Where there is flow of water the stream transports considerable sedi-

ment, but the trend seems dominantly to be the removal of material which had formerly been deposited in the caves.

The modern streams transport silt, sand, and cobbles, apparently derived from the overlying Pennsylvanian sandstone and the mantle of loess. Deposits occur in protected places in the caves and, in low water, as bars and bottom deposits. The large load transported is apparent after heavy rains when changes in amount and location of material may be noted. The floor of most of the caves contains large blocks of limestone and cobbles of chert, limestone, sandstone, and conglomerate. The large blocks have obviously fallen from the roof and have not been transported far. The conglomerate and sandstone cobbles have been brought in from the overlying formations presumably through sink holes. So far as we have observed, the portion of the ridge above Rich's Cave does not now have a Pennsylvanian cover yet cobbles of this formation are abundant. These seem to have been derived, at least in part, from the older fill still present in side passage.

Evidences that the cobbles are transported today during high water are of two types: (1) imbricate arrangement on rock ledges and on the stream floor, and (2) piles of cobbles partially filling constricted portions of the cave. Illustrative of this is a place in Rich's Cave not far downstream from the sink entrance where there is a narrow vertical slot with a wide but low bedding cavity. The stream normally twists about in the bedding cavity, but at high water the bedding cavity is filled. A con-

striction in the vertical joint causes increased velocity, but just below the constriction a pile of cobbles has accumulated in the joint.

Ancient detrital fill is an outstanding characteristic of the caves. Lilly Cave has been so nearly filled that in most places the explorer must travel on hands and knees or by crawling flat on his stomach. The floor is largely silt but in one area visited by the writers it is red clay. Collapse of this debris in a few passages indicates some removal from a lower level. A spring occurs in the limestone about 75 feet below the cave entrance.

Lilly Cave is certainly the largest solution cavity which we have observed. It is not well known as we have not explored it extensively nor has it been mapped. Exploration is slow because of the restricted passages and poor circulation of air, but our preliminary investigation adequately indicates the nature of the cave and something of its size. Detritus seems not quite to have filled the cave—or possibly compaction has caused an opening of 6 inches to a foot in the large rooms. A somewhat higher passage exists along the joints. The former room cavities must have been large with a great flat roof. In the largest collapse area undissolved limestone pillars rise above the debris, but between pillars one can look out many yards in three directions over the top of the debris. Stratification of the silt and sand can be seen in one rather fresh collapse area.

A stream is actively removing fill from the Cobden Cave. The stream enters through a sink hole, flows along the joint, and at the far end

has opened a small tunnel through more debris (fig. 4). A tributary, also opened by a stream, joins the main stream just before the tunnel. The tunnel is not large enough to penetrate and the tributary has not yet been investigated. The many cross joints shown in the diagram of Cobden Cave are filled by debris. Some of the cross joints appear originally to have been enlarged as much as the present passages, but have not been opened again. In some of them there is complete fill, in others a low passage between roof and fill is used by racoons. An occasional trickle of water is indicated by a small erosional channel at the lip of the fill. The stream flowing 6 to 8 feet below the roof has undercut the debris in the cross joint, eroding it some 20 feet or more. Rich's Cave also exhibits a few large cross-joint passages which have been filled by debris. Some are now filled to the roof, others have a passage large enough for racoons. Such filled passages have not been observed in either Guthrie Cave or Union Point Cave, although these caves have yet to be completely explored by the writers.

The sequence of fill visible in cross joints of Rich's and Cobden caves is the normal sedimentational sequence of coarse material at the bottom and fine at the top. The lower several feet, where observable, invariably contain large blocks of chert, conglomerate, sandstone, and an occasional limestone cobble. These are surrounded by quartz sand and pebbles derived from the overlying sandstone. Excavation in one cross joint of Cobden Cave uncovered a block of unconsolidated, stratified

reddish clay, interbedded with silt. Whether or not this indicates the former existence of a red clay fill cannot be stated with certainty. The stratification is atypical.

The uppermost foot or two of fill contains no coarse material; it is well but finely stratified. In Rich's Cave a good section 8 inches thick is finely stratified buff silt. We believe this silt is derived from the loess mantle.

Extremely fine-grained unstratified red clay has been observed only in Lilly Cave in the Cobden area, although the large Cave Hill Cave and Ava Cave likewise contain it. The red clay in Lilly Cave was found in a passage from which the silt normally found above it had apparently been removed. This passage-way was very close to the present surface of the ground as indicated by numerous flowstone deposits in the joints and across the top of the fill. The clay appears to be the typical colloidal clay described by Bretz and other cave workers. It is distinctly older than the coarser debris.

All the caves, with the exception of Lilly Cave, have a stream flowing through them. Erosion by solution and abrasion, by the sand load, is active. The limestone is smooth and polished in the stream bed and along the lower part of the walls, whereas the upper portion of the walls is pitted and irregular. Solution work in the upper part of the passages is much slower and apparently is brought about by a thin film of water.

Tributary branches are known in Guthrie and Cobden caves. Union Point Cave is T-shaped with the mouth at the base and tributaries

along the arms. The water is always rather deep in this cave, as the entrance is at a higher elevation than the bottom of the arms. This cave has not been thoroughly studied yet. At high water it is not enterable. Solution work has been active to a level below the outlet, but the clastic load of silt and sand is moved out by the current.

The tubular passage in Rich's Cave is being actively enlarged by the stream. It appears to be a relatively recent feature and undoubtedly has been made largely by flowing water. The roof, as well as the walls, is fluted.

The role of the modern stream in Cobden and Rich's caves seems to be dominantly the removal of older debris fill. The network pattern of Cobden Cave and the several large cross-joint passages in Rich's Cave is strong evidence for a phreatic origin. Guthrie Cave shows far less indication of phreatic features although it alone is today near the valley bottom. The other caves, though now high above the valleys, contain such phreatic features as network pattern, anastomosis, tapering joint slots, joint-determined roof and wall cavities, and one has a partial rock span. The colloidal clay fill in Lilly Cave and the coarser debris in that and other caves indicate a history not attributable to the modern stream.

REVIEW OF CAVE HISTORY

Although each cave shows special features, a general sequence of events may be suggested.

It is obvious that Lilly and Cobden caves, now high on the escarpment face, are not recently formed

caves. These appear to be the oldest caves and have the most complex history. Their network pattern of solution along joints indicates phreatic origin at a time when the water table stood high. Probably the escarpment was remote and the adjacent valleys shallow. Rich's Cave is on the back slope less than a half mile from Cobden Cave but nearly 100 feet lower. It, too, contains a few enlarged cross joints, but they are not so extensive as in the two caves just described. Apparently the cave is younger and may not have formed until the adjacent valley allowed rather rapid movement of groundwater toward it. Besides the partial network development, slotted vertical joints and anastomosis suggest phreatic origin.

After the major stage of solution, and possibly partly contemporaneous with solution, there came a stage of fill by fine-grained clays. This clay is believed to be residual from the limestone. Bretz suggests that it accumulated at a time of very slow groundwater circulation, possibly under conditions of peneplanation. The caves on the back slope of the escarpment probably never reached this stage.

Rejuvenation of the region near Lilly and Cobden caves brought about increased circulation of groundwater in the caves and partial removal of the clay. Much debris was carried into the cave, including cobbles up to a foot in length. Rapidly flowing water, presumably un-

derground streams, must have transported this material. Sections of the debris in Lilly Cave do not extend to the bottom of the solution cavity, and such coarse material has not been seen in that cave. However, both Cobden and Rich's caves exhibit it in every debris-filled, cross-joint passage. The upper foot or 6 inches of material is finely stratified buff silt, derived largely from the loess mantle, and represents the final stage of fill.

The filling in these caves is not yet accounted for. The last deposit of silt suggests that the time was late Pleistocene. The Illinoian glacier terminated only a short distance north of the caves. Meltwater was ponded by the ice and overflowed southward across the escarpment along Drury Creek valley and probably along other valleys as well. Future study of the physiography of the area will investigate terraces on these streams, in the hope of determining whether or not the terracing may have raised base level sufficiently to cause sedimentation in the caves. This seems a reasonable possibility in respect to Rich's Cave, but is somewhat doubtful in respect to the very much higher Cobden Cave.

The last stage, still in progress, is the removal of detritus by subterranean stream erosion. Some additional solution is going on today, especially in the domes and along the floor of the caves, but the main cavities seem to have been formed in a previous cycle.