SPECIAL TOPOGRAPHIC FEATURES AND THE PHYSIOGRAPHIC BACKGROUND OF THE BLOOMINGTON INDIANA QUADRANGLE.

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The purpose of this paper is to present a brief description of the chief topographic characteristics of the Bloomington Indiana Quadrangle. It is rather unusual that an area of country which is bounded by arbitrary methods should possess so many features of interest to the physiographer and geologist. It is true that much of its topography is but a continuation of that beyond the mapped limits; nevertheless, the positional relations of the area are such that one finds great diversity of topographic forms and a grouping of physical features that would be difficult, if not impossible, to find in other locations.

It was the privilege of the writer as a student of Indiana University, to make a study of this region. As a part of the study and as an aid to the interpretation of its topographic features, a relief model of the area was constructed. The model has the advantage of showing at a glance the positional relationships of the varied surface features to one another and to the structural conditions of the rock formations—relations that are not so easily interpreted from the flat map and which are more or less difficult to determine in the field.

POSITIONAL RELATIONS.

Location and Area. The Bloomington Indiana Quadrangle was topographically mapped by the United States Geological Survey during the years of 1907 and 1908. According to this survey, the boundaries were established as the meridians of 86° 30′ and 86° 45′ W. and the parallels of 39° and 39° 15′ N. The quadrangle is 15 minutes square and contains approximately 231 square miles. In includes portions of Owen, Monroe, and Greene counties. Monroe County forms the largest part of the area. The quadrangle is named for the city of Bloomington, which is located in the northeast part of the area.

Major Physiographic Divisions. The quadrangle is a small part of the Central Plains area of the United States. According to Fenneman's classification of physiographic divisions it would fall in the Interior Plains Division, Interior Low Plateaus Province, and in the Western Section (unnamed) of that province. Although this positional relation is not a special one, it is mentioned here because of the fact, that in the treating of a local area, it is easy to overlook the larger physiographic divisions of which it is a part. As a part of a larger physiographic division the area has been subjected to much the same influences of denuda-

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tion and climate that have given to the larger unit its outstanding surface characteristics. Detailed differences in its surface characters are to be interpreted from the study of local environments.

The Bloomington Quadrangle is a region that well merits consideration from the standpoint of the positional relations that have influenced the development of its topography; and perhaps, it is not excelled elsewhere in the number of local physiographic studies that it affords.

Minor Physiographic Divisions. Relative to the Interior Plains division, the physiographic divisions of Indiana are smaller units of the larger division. In "The Physiography of Indiana," Malott recognizes for the south portion of the state from east to west the following units: Dearborn Upland, Muscatatuck Regional Slope, Scottsburg Lowland, Norman Upland, Mitchell Plain, Crawford Upland, and Wabash Lowland. Three of these physiographic divisions are represented in the Bloomington quadrangle viz., the Norman Upland, Mitchell Plain and Crawford Upland. Of these the Mitchell Plain and Crawford Upland are more typically represented in the area than the Norman Upland. The following figure illustrates the positional relation of the quadrangle to these physiographic units. (Fig. 1.)

Fig. 1—The location of the Bloomington Quadrangle is shown by the square. The figure shows its relation to the physiographic divisions of the state.

Illinoian Glacial Margin. The larger part of the quadrangle is in the unglaciated section of the state. (Fig. 2). The Illinoian Glacial margin however, crosses the extreme northwestern part of the area. Near Stogsdill pond, sections 2 and 3, T9N, R3W, there is the remnant of an old glacial moraine in which quartzitic and granitic boulders may be found. The moraine is not extensive and within a short distance abuts against a bed rock ridge. A possible explanation for Stogsdill pond is that it occupies a morainic depression. The pond is of further interest in that it contains a relic Arctic flora, particularly a species of water lily that covers a large part of the pond's surface.

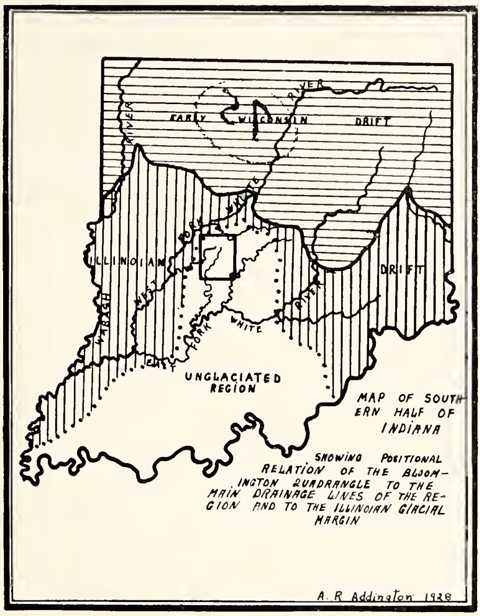

Fig. 2—The quadrangle is represented by the square. The stream shown crossing the northeast corner of the quadrangle is Beanblossom Creek. The stream crossing the southeast corner is Salt Creek. The stream heading near the central part of the area is Indian Creek. The stream flowing from the western part of the area is Richland Creek.

The greater part of the glacial materials in this part of the quadrangle are relatively fine, consisting of silts, sands, and gravels that are more typical of glacial outwash than glacial moraine. These deposits form for the most part but a veneer over the solid rock, so that the latter exercises the dominant surface control.

Drainage. The drainage of the quadrangle is a part of the Mississippi drainage. The immediate large streams adjacent to the area are the West Fork of White River situated to the west and north and the East Fork of White River situated to the south. The topographic divide for these streams passes through Bloomington and may be traced in a general southwesterly direction across the quadrangle. (See fig. 2).

Considering the area as a whole, the drainage is characteristically surface drainage, but where limestone forms the subsurface rock subterranean drainage is excellently developed. This type of drainage is best developed near the entrenched valleys and valley heads that margin the limestone platform.

It is somewhat interesting to note that the apparent topographic divide between the forks of White River does not exactly coincide with the division of drainage to these streams, since some of the drainage is diverted through subterranean routes beneath the topographic divide. A specific example of this sort of thing is illustrated near Truitt's Cave, where a small stream sinks into the limestone, passes beneath the sandstone capped ridge, and emerges as a spring in a small tributary to Richland Creek. Richland Creek is tribuary to the West Fork of White River, entering the latter near Bloomfield, Indiana. The drainage that now passes through the subterranean route above mentioned formerly was a part of Indian Creek drainage, which is a tributary to the East Fork of White River. The above is not the complete story of the drainage changes occurring in this region, but it serves to illustrate a shifting of drainage divides by an interesting case of stream diversion.

Geological Formations. It is rather difficult to give special attention to the topographic features of the quadrangle without taking into

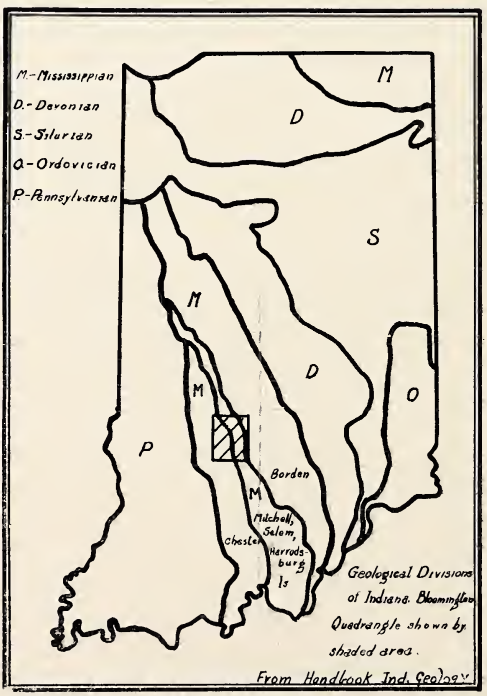

Fig. 3—The figure shows the relation of the quadrangle to the regional distribution of the geological formations. The outcrops of Pennsylvanian rocks on the quadrangle are not indicated by the figure.

account the areal extent, stratigraphical relations, and lithologic characteristics of the rock formations, for the latter form, so to speak, the foundations upon which the topographic architecture stands. The positional relations of the quadrangle to the geological formations can best be understood by reference to figure 3. It will be noted that the strike and dip of the formations and their general stratigraphical relations are representative of the south part of the state as a whole.

The rock formations having outcrop in the quadrangle are Paleozoic sediments of Mississippian Age with a little of the lower Pennsylvanian capping the ridge crest in the western part of the quadrangle. There are upon some of the higher elevations, notably in the southern part, gravels of Tertiary Age, and in the northern and northwestern portions the glacial materials, previously mentioned, which belong to the Pleistocene. So far as influence upon topographic development is concerned, the Paleozoic sediments and the Pleistocene deposits are the most important for this region.

If one crosses the state from east to west he passes over successively younger formations. In order these formations belong to the Ordovician, Silurian, Devonian, Mississippian, and Pennsylvanian systems. On the quadrangle the Mississippian and Pennsylvanian systems are represented by the following formations in order from east to west and oldest to youngest: the Borden Series (Riverside sandy shale member), the Harrodsburg limestone, the Salem limestone, the Mitchell limestone, the Chester series, and the Mansfield sandstone. The Chester series consist of intercalated sandstones, limestones, and shales that constitute the most complex geology of the entire area.[1]

Physiographic Processes Involved.

Diastrophism. Ancient crustal movements that gave rise to the Cincinnati Anticline were responsible for the gentle westward tilting of the rock formations in this region. The central axis of the anticline extends in a general NW.-SE. direction across the state, so that areas located in the central southern section are underlaid by westward dipping sediments. A glance at figure 3 will make this general relation clear. This diastrophic movement is responsible for the present attitude of the subsurface strata and they in turn exert an important control upon the topographic development of the region. The topography would be noticeably more uniform if the rocky formations were horizontal.

It should here be pointed out that more recent crustal movements, especially during the Tertiary, and perhaps following the Pleistocene have contributed to the present topographic condition. The present altitudes of the Early and Late Tertiary peneplain remnants, the deep dissection of the uplifted peneplains, and certain drainage adjustments, are a few of the results, directly or indirectly, of these more recent crustal movements.

[1] For the details of the Geology of the Bloomington Quadrangle, see J. W. Beede and others, *Geology of the Bloomington Quadrangle*, 39th Ann. Rept. of the Ind. Geol. Survey, for 1914 (1915), pp. 190-229. Also Handbook of Indiana Geology, 1922, pp. 475-530.

The Processes of Denudation. The processes of weathering and erosion are the important processes that operate upon any elevated land mass. Given sufficient time the total result of their work is regional denudation and the resultant land form is the peneplain. The peneplain stage is not attained, however, without the appearance, modification, and eventual disappearance of many diverse topographic forms, and it is they that environ us as silent reminders of the regional transformation now in progress.

The processes of denudation operate chiefly through the agencies of wind, water in its various forms, atmospheric gases, and organisms. It is a very difficult thing to assign to an agent or process its relative importance in creating the topography of a region, especially, a region where numerous agents and processes are involved. The Bloomington Quadrangle is an area representative of this condition. Here the agencies of running water, groundwater, glacial ice, and the mechanical and chemical processes of weathering are evidenced by the existing topographic forms. Perhaps the outstanding topographic expression of the region is its intricate network of ridges and valleys, which, especially in the western part of the area, are conspicuously molded. With certain local exceptions, the remainder of the region has extensive ridge and valley development, but with a softness of detail that stands in marked contrast to the bold and rugged features of the western part. This ridge and valley topography is most certainly to be associated with the agency of running water, but there are other factors and processes to be considered if interpretation of local topographic differences is attempted.

CONDITIONING FACTORS INVOLVED.

The topography of a region is not solely due to the processes that have operated upon it. The topography is conditioned to some extent by the climate of the region, by the attitude, exposure, and lithologic characters of the subsurface rocks, by the altitude of the region, and by the length of time the processes of denudation have been at work.

Climate. Climate as a factor in topographic development should be considered as the sum total of weather conditions rather than the average weather. It is not the average weather that operates upon a region to make that region what it is, but the conditions imposed by the weather cause the operation of certain processes which produce the results. In this respect climate is a very fundamental control, for its elements of temperature, moisture, and wind are the very bases of origin of the physiographic agents and physiographic processes that modify the land's surface.

The Bloomington Quadrangle is in a climatic region where the elements of temperature and moisture assume the ascendency as climatic controls. It is impossible to assign definite values to the relative importance of these elements as factors in the topographic development of this region.

Rock Attitude. The fact that the rocks of this region are tilted brings to the surface a series of rock formations of different lithologic characters. The amount of tilting and the thickness of the formations governs the amount of their areal exposure. Obviously, other conditions remaining constant, the topography of this region would be considerably different from what it is now, were the rock formations tilted at any greater angle or were they horizontal.

Under the present conditions of tilting there is exposed within relatively short distances several different types of rock each of which supports its own type of topography.

The cuesta-like form, to be observed in the southern part of the quadrangle, is a feature that owes its existence just as much to the tilting of the subsurface rocks as it does to the processes that have operated upon them.

Lithologic Characters. The influence of lithologic control is most strikingly brought out where there are marked changes in lithologic units. In the Bloomington Quadrangle the verity of this statement is attested by the development of a karst topography with its numerous sinks, swallow holes, caverns, and disappearing streams, which are most characteristically found in those areas where the Mitchell limestone is the immediate subsurface rock. Where the Riverside member of the Borden series forms the subsurface, karst features are absent and steeply walled valleys, well graded valley floors, and absence of sheer cliff exposures are characteristic. The first is a well jointed, thin bedded, dense limestone, and the second is a relatively little jointed, impervious, shaly formation. Surely, this is sufficient evidence that topographic variations are in part due to differences in rock characters.

Altitude. The altitude of a region is a factor in its development for altitude determines the depth to which a region may be entrenched by streams. In general, the higher the region above the sea, the bolder its topography.

The Bloomington Quadrangle is a region of moderate elevation; consequently, pronounced or extreme entrenchment by streams is impossible under the present altitude conditions. But in so far as relative ruggedness or boldness of topographic forms is directly related to the amount of stream entrenchment, which in turn is dependent upon the altitude of the region, it is necessary to consider altitude as a factor in topographic development.

Time Factor. To those who are familiar with geological processes it is unnecessary to comment upon the importance of time as a factor attendant upon changes of the land's surface. Let it be sufficient to say that the evolution of the present topographic forms represent the processes of land sculpture that have operated through long time periods. The topographic forms are what they are, in part at least, because of the time during which the sculpturing processes have been at work.

TOPOGRAPHIC FEATURES ADJACENT TO THE ILLINOIAN GLACIAL MARGIN.

There are a number of topographic features represented that are associated with the Illinoian glacial margin. For the most part, these features are the result of drainage adjustments attendant upon the advance and recession of the Illinoian ice sheet. A very small amount of the topography is due directly to glacial deposition.

Lake Flatwoods Basin. Near the north margin of the area and to the west of Ellettsville, there may be observed a plains-like expanse of a few square miles. This is a small part of the basin of Glacial Lake Flatwoods.[2] The area owes its plains-like character to the deposition of lake sediments that now smooth over a somewhat more rugged subsurface. It is probable that some of the flatness is structural in that the Mitchell limestone forms the subsurface rock.

The drainage of this lake basin is now by way of McCormick's Creek to the west fork of White River. Before the present drainage was established the lake had a number of overflow outlets and one of these may be observed in the southeast part of section 1, T9N, R3W. Here the waters overflowed into a tributary valley of Racoon Creek.

Drainage Adjustments. All of the larger stream valleys represented upon the quadrangle were modified to some extent as a result of glacial obstructions to the stream courses. These obstructions are without the limits of the area and the extent to which they resulted in modification of the valleys and stream courses varies considerably within the region.

The most conspicuous case of drainage change is represented in the extreme northwest part of the quadrangle in sections 11 and 14, T9N, R3W. Here streams disappear and farther south emerge as springs in the valley of Raccoon Creek. Field study leads to the conclusion that, prior to the advance of the Illinoian ice, there was surface drainage from the area to the northwest and that subterranean drainage was established beneath the sandstone capped ridges. The deposits of glacial outwash destroyed the existing surface drainage, clogged the subterranean routes and overflow for a time was in progress through a low gap in the ridge. Since glaciation there has been a return to subterranean drainage through re-excavation of old routes or creation of new ones and a new system of surface drainage has been established.[3]

There is a suggestion that Raccoon Creek formerly flowed to the north of Freeman Hill rather than to the south as at present. Freeman Hill, T9N, R3W, section 22, is a bed rock hill, but the flat topped ridge immediately north is composed entirely of outwash materials, no bed rock being exposed in the ravines. At Freeman the stream goes through a relatively narrow rocky gorge. These conditions are very suggestive of drainage derangement. The general statement that these changes of drainage are related to the Illinoian margin is very insufficient and they merit careful investigation.

A case of drainage change almost duplicating that of Raccoon Creek is shown by Bean Blossom Creek in section 4, T9N, R1W. Here the

[2] C. A. Malott, "Handbook of Indiana Geology," pp. 211-215.

[3] A. R. Addington, A Special Case of Drainage Adjustment Near the Illinoian Drift Margin in Southeastern Owen County, Indiana. Proc. Ind. Acad. Sci. 1925, pp. 125-130.

stream passes to the south of a knob-like hill of Riverside sandstone. North of the hill there is a rather wide gap that is filled with terrace materials. It is entirely possible that before the present valley was in a laked condition the stream flowed through the valley depression north of the knob.

Alluvial Terraces. Alluvial terraces are present in all the larger stream valleys of the quadrangle. They are best developed in the valleys of Raccoon, Richland, and Bean Blossom creeks. Low terraces are present in the valleys of Salt and Indian creeks near the points where these streams flow from the quadrangle.

The terraces of Bean Blossom Valley early attracted attention and their origin was suggested by Marsters[4] as due to deltas of incoming streams, a condition not in harmony with the materials of the deposits or with their positions in the valleys. The materials of the terraces are finely stratified silts, some of the stratification being so fine that it is scarcely perceptible to the naked eye. The alluvial terraces of the quadrangle are apparently the result of partial excavation of lake silts that had accumulated in the creek valleys when they were in a ponded condition. When the lake waters were drained away the streams began excavation of materials of the lake flat. The terraces we note today are the erosional remnants of the former existing lake bottom.

The alluvial terraces in the Bloomington quadrangle vary from four feet to 60 feet in height. Those of Bean Blossom Creek average about 40 feet, those on the lower portion of Richland Creek average about 60 feet. Low terraces are found near the margins of the old lake basins. The terraces form conspicuous topographic features of the larger creek valleys.

Rejuvenated Sinks. It is not unreasonable to assume that considerable areas over which the ice advanced were characterized by the presence of numerous sinks of various shapes and sizes. Where the sinks were located in regions of glacial deposition they were in many cases filled with the glacial materials, so that evidence of their previous existence was obliterated. Following the recession of the ice the glacial materials filling the sinks have been removed through underground passages, so that new depressions have appeared in the positions of the older ones. There are those sinks where nearly all or all of the glacial materials have been removed, and there are others where the processes of removal are still in operation. Sinks of this character are located in the northwest part of the quadrangle.

In those situations where the stream valleys were ponded and the terrace filling was sufficient to mantle over the limestone rock of the valley sides, we find sinks whose basins are margined by terrace materials. Sinks of this character are excellently developed in Section 23, T9N, R3W. These sinks differ from those mentioned above merely in the character of the materials margining the depression. There is room for discussion relative to the post glacial or pre-glacial origin of some of the bed-rock depressions.

[4] Proc. Ind. Acad. Sci. 1921, pp. 222-237.

Filled Valleys. It has been stated that all the main valleys of the quadrangle were affected by glacial obstructions and, due to this, it would be inferred that some valley filling would result, but it should be pointed out that relative to the valleys of Bean Blossom and Salt creeks the filled condition is due in part to the overloading of their streams with glacial materials. These streams and their tributaries head upon the glacial drift and during the period of advance and recession of the ice mass abundance of glacial detritus was supplied to them and to their tributary streams, resulting in the building up of the valley floors and the widening of the valley flats.

The valley-fill materials are assorted sands and gravels that in the Bloomington Quadrangle are found below the lake silts. Drill records show a depth of 80 feet of unconsolidated materials in Bean Blossom Valley. Records are not available for Salt Creek Valley in this region, but it is estimated the amount of valley-fill is less than in Bean Blossom Valley.

The rather broad and flat valley bottoms, margined by steep valley walls, in some places surmounted by cliffs of limestone, and the numerous sharp ravines etched in the valley sides, characteristic of Bean Blossom and Salt Creek valleys and their tributaries, form two very conspicuous topographic areas of the quadrangle. This topographic condition is related to glaciation only in so far as glaciation was responsible for the filled valley condition. The topographic details of the valley margins are to be explained by differences in rock characters of the Riverside sandstone and Harrodsburg limestone.

TOPOGRAPHIC FEATURES INDEPENDENT OF GLACIATION.

Karst of the Bloomington Region. Features characteristic of karst lands are numerous and are excellently illustrated here. Caverns, sinks of various types and stages of development, swallow holes, subterranean streams, and subterranean piracy are all features of a karst region which form a prominent part of our natural laboratory. But little space can be allotted to a discussion of them here.

Caverns. There are approximately 50 caverns situated within a radius of 20 miles of Bloomington. Most of these are located to the west and south of the city, and for the greater part are found in the Mitchell limestone. In comparison with some of the better known caves of the state they are small and are but little more than water-worn channels in the rock.

The entrances to some of them are rather spectacular features and are part of an environment that is more or less of interest to the visitor or pleasure seeker (fig. 4). Some of the entrances are of the mouth type as the accompanying illustration demonstrates; other entrances are sink holes (fig. 5) that perhaps appeal to the imagination less than the yawning mouth entrance.

Without attempting a definite classification, I believe three types of caverns may be pointed out in this region. There is the type that is characterized by extensive room development such as Truitt's cavern. Here large underground cavities are connected by more or less zigzag

Fig. 4—The entrance of Boone Cavern, a typical mouth entrance, located in the northwest part of the quadrangle. Entrances of this type are among the most spectacular to be found on the quadrangle. The dimensions of the entrance are 24 x 7 feet.

Fig. 5--View of a cave entrance at the bottom of a sink hole. It is representative of the sink type of entrance, although the illustration does not show the profile of the sink.

passageways which follow the rock fractures, their zigzag character being a result of the system of rock joints (fig. 6).

There is the tubular type of cavern. Such is devoid of extensive room development. Its passageways follow the bedding planes and joints of the rock. This is characteristic of those caverns found in the Salem limestone. Contributing factors are the relatively uniformly porous character of the rock, its massive character, its thickness, which is much less than the Mitchell limestone, and its less extensively jointed character (fig. 7).

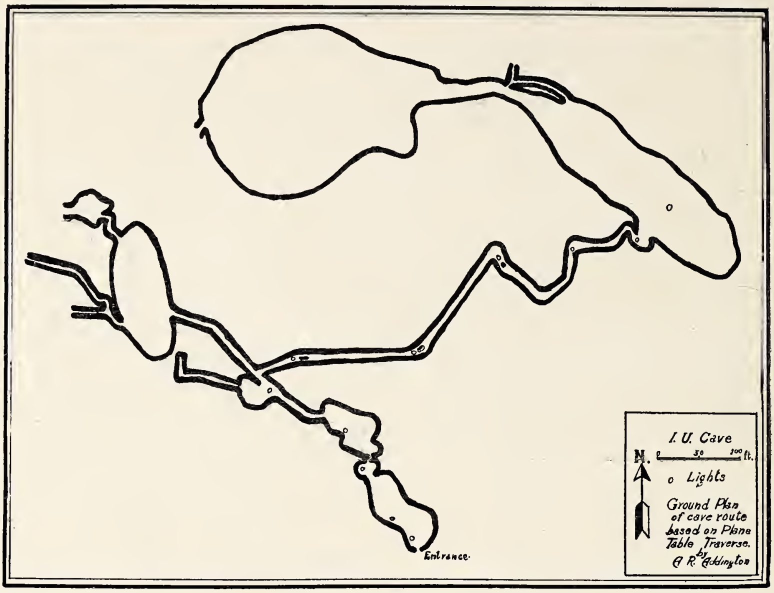

Fig. 6—A ground plan of I. U. Cavern, 5 miles west of Bloomington. It illustrates the type having large rooms. The angular character of the narrow passageways is due to jointing of the rock. The parallel alignment of the large rooms is doubtless a joint controlled phenomenon.

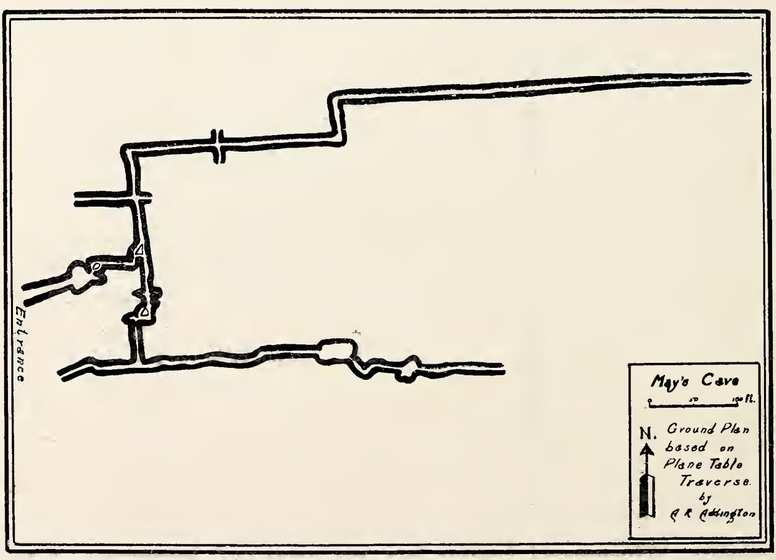

Fig. 7—The tubular type of cavern. In contrast to the type shown in figure 6. it is to be noted there is an absence of extensive room development. The cavern is in the Salem limestone. It is but little more than a rock worn groove.

A common characteristic for the types mentioned above is their greater horizontal extent as compared with their vertical extent. I mention this for purposes of contrast with a third type which has greater vertical extent. This is a well-like cavern, sometimes having a yawning, awe-inspiring, well-like opening that leads to a more or less jug-shaped interior. There are several caverns of this type that are located near the eastern border of the Crawford Upland, a location that is generally characterized by considerable local relief. Exploration of this type of cave does not disclose any horizontal passageway that can be followed. This does not preclude, however, the possibility of such passageways being clogged by weathered detritus from the entrance, thus affording no visible evidence of their existence.

Sinks and Sink Hole Ponds. The margin of the perched limestone plain to the west and south of Bloomington illustrates various stages of sink hole development. In a general way the larger sinks are adjacent to the entrenched valley heads of the plain, and within the larger sinks may be observed younger and smaller depressions. The shapes of the sinks are varied, some are beautifully circular in outline, others star shaped, and others shaped so as to defy description. It may be a mere coincidence, but these features cluster in greater numbers about the bases of the monadnock-like features of the plain.

In some instances the bottoms of the sinks become plugged with clay, either by natural or artificial processes, and a pond then occupies the depression. It is not an uncommon sight to find in close juxtaposition sinks that are ponded and those that are not. A bird's-eye view of a surface dotted with sinks reveals a topography of a peculiar rolling character, with numerous basins separated by undulating ridge-like divides, the monotony of the entire landscape broken here and there by sink hole ponds in the depressions.

Subterranean Piracy. The drainage history associated with the former headwaters of Indian Creek has been discussed by Beede[5] and so does not demand detailed discussion in this paper. By way of review it may be pointed out that Indian Creek formerly flowed as a continuous stream from a point some two miles west of Bloomington until it joined the east fork of White River near Shoals. Its headwaters were situated upon a plain underlaid with the Mitchell limestone, a highly jointed limestone formation. By rejuvenation this limestone plain attained a perched position relative to the valley levels on either side, with the result that subterranean drainage was established and the headwaters of Indian Creek were diverted to valley levels on either side of the limestone platform, thus exemplifying cases of subterranean piracy.

Topographic evidence of these drainage diversions are present today in the form of a valley depression that extends from the position of the former headwaters to the present valley of Indian Creek. Considerable modification of the valley has occurred since the time of the diversion of the headwaters.

[5] J. W. Beede, *The Cycle of Subterranean Drainage as Illustrated on the Bloomington, Indiana, Quadrangle.* Proc. Ind. Acad. Sci. 1910, pp. 91-111.

Limestone Springs. It is an inevitable result in regions where surface streams become subterranean that the streams will ultimately reappear in the form of large springs. Many of these springs are to be found in the valley heads that entrench the limestone plain. Leonard's Springs, Stony Springs, Blair Springs, and the Breeden Spring are but a few of the large limestone springs of the region. Such springs vary widely in volume and almost directly with the precipitation, a condition that indicates rapid transfer of surface waters through the subterranean routes. The waters of such springs are relatively easily contaminated, and due to the character of the rock from which they emerge they cannot be successfully impounded for purposes of municipal supply.

Kirksville Ridge. The Kirksville ridge is the most prominent topographic feature of the south central part of the quadrangle. From selected places on or near its summit, on a clear day, one can see for a distance of 20 miles to the eastward. Views from it are among the best obtainable in the Bloomington region.

As a topographic feature the somewhat extensive axial summit of the Kirksville ridge is the remnant of a peneplain of early Tertiary Age. This was a peneplain of wide extent, but is now represented only by the summits of the higher ridges and hills that reach elevations of 900 feet or more. Corresponding levels are found in Kentucky, Tennessee, Ohio, Pennsylvania, and elsewhere.

It is from the summit of this ridge to the valley levels of tributaries to Clear Creek that the greatest local differences in relief of the region are found; differences amounting to 300 feet or more within one-half mile.

The ridge contains features of interest in the presence of well-like caverns, sandstone rimmed sinks, and parts of a small coal basin.

Late Tertiary Peneplain. From the summit of the Kirksville ridge one may observe long spurs of land of relatively uniform elevation extending in a general easterly direction. The present stream courses are well entrenched below the level of these land masses. The summits of these ridges represent a partially completed peneplain of probable late Tertiary Age. The elevation is approximately 700-760 or about 200 feet below the level of the remnants of the older peneplain surface. Similar elevation relations are found in other areas, notably in Brown County, where the subsurface rocks are of relatively uniform lithologic characters. Consequently, the two levels form a topographic condition that is not to be explained on basis of lithologic difference of the subsurface rocks.

Minor Topographic Features. It is true that the topographic condition of the entire region is more or less associated with the development of the present cycle of erosion; but there are hosts of minor surface details that came into existence during and following the last rejuvenation of the region. These features are for the most part the present valley depressions, with their intricate detail of marginal ravines, cliff exposures, overlapping spurs, valley monadnocks, entrenched meanders, cascades and rapids. Some of these features, such as the cliff exposure at Cedar Cliffs, the entrenched and meandering character of Clear Creek Valley, and the small cascades north of Bloomington, form rather conspicuous details of the landscape. They are but temporary features, and their existence connotes the ever changing contour of the earth's surface. Tennyson has so beautifully expressed these changes as follows:

"The hills are shadows, and they flow
From form to form, and nothing stands;
They melt like mist, the solid lands,
Like clouds they shape themselves and go."

Summary.

The Bloomington Indiana Quadrangle is a plains region characterized by great diversity of topographic forms. The diversity of its surface features is partly the result of its marginal location to the glacial drift, partly the result of the differences in lithological characters of the subsurface rocks, and more directly to the processes of denudation that have operated upon its surface.

The area is especially interesting from the standpoint of the number and variety of the physiographic problems that it affords. Outstanding in this respect are the features typical of Karst regions.

The present paper does not attempt to completely describe all the topographic features or to explain in minute detail the various stages of their development. Such presentation would in itself form a voluminous piece of work. The writer will be satisfied if he has succeeded in presenting the physiographic background and a brief description of the significant topographic features which are so abundant in the Bloomington Quadrangle region.