Origin of the Mitchell Plain in South-Central Indiana[1]

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The pre-karst surface of the southern part of the Mitchell Plain was leveled by surface streams of late Tertiary age that headed on the plain or within the Norman Upland and flowed through re-entrant valleys in the Crawford Upland into the pre-Pleistocene Ohio River. The karst features and subterranean drainage characteristic of the Mitchell Plain developed as a lower base level was established by rejuvenation during the late Tertiary or early Pleistocene.

These ancient stream routes were first noticed on the Corydon West, Depauw, Fredericksburg, Hardinsburg, Leavenworth, Mauckport, Milltown, and New Amsterdam topographic quadrangles, which cover part of the Mitchell Plain and the Crawford Upland. The ancient stream courses are represented by three kinds of topographic features which are well shown on these maps: hanging dry valleys, bedrock terraces, and abandoned meander loops. The topographic features were checked on aerial photographs and in the field to determine their geologic characteristics.

The fossil drainage system studied occupies part of the present drainage basins of Blue River, Indian Creek, and Buck Creek, which are tributaries of the Ohio River (fig. 1). This combined drainage area includes approximately 900 square miles mostly in Crawford, Harrison, and Washington Counties. This drainage basin includes parts of three physiographic units: the Norman Upland, the Mitchell Plain, and the Crawford Upland (2). The Norman Upland is upheld by resistant shales and siltstones of early Mississippian age, which form an eastward facing cuesta that is called the Knobstone Escarpment. These rocks dip westward about 30 feet to the mile and pass beneath the Mitchell Plain. The upper surface of these nonsoluble rocks is the ultimate base level of karst development in the Mitchell Plain.

Figure 1. Map of south-central Indiana showing the location of drainage features.

The Mitchell Plain is a karst plain that has formed by solution of a thick series of limestones of middle Mississippian age. In general, the plain is streamless and appears low and rolling, but it is transected by three master streams, the two forks of White River and the Ohio River, in meandering valleys that are entrenched about 250 feet into the karst plain. Those surface tributaries to these master streams that head within the Mitchell Plain or in the Norman Upland just west of the Knobstone Escarpment also have deeply entrenched meanders within the lower reaches of their valleys. For example, the lower courses of Blue River, Indian Creek, and Buck Creek lie about 100 feet below the Mitchell Plain and about 300 feet below the summits which have been considered as remnants of an older peneplain or erosion level (fig. 2).

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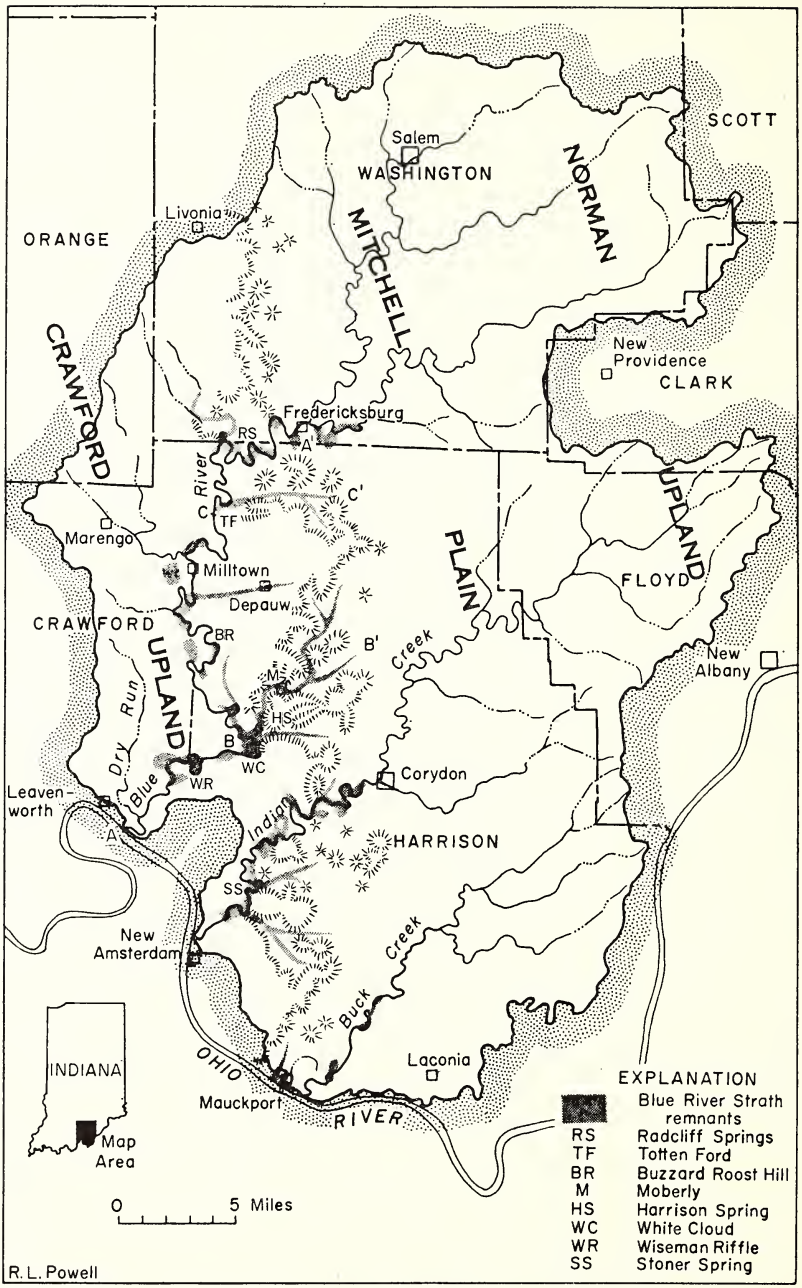

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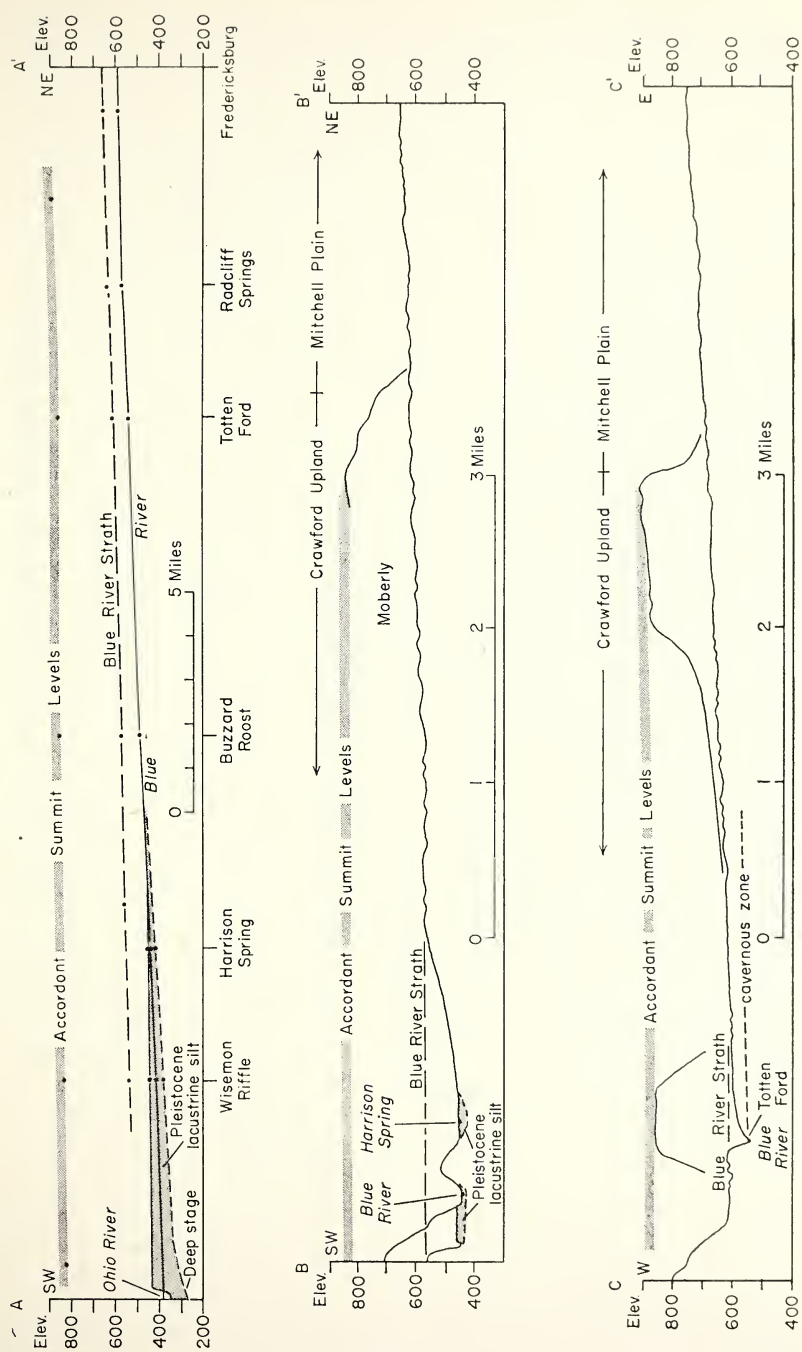

Figure 2

A. Generalized profile showing the character of the Blue River Strath between Fredericksburg and the Ohio River.

B. Profile of the strath extending from Harrison Spring to the Mitchell Plain.

C. Profile of the strath extending from Totten Ford to the Mitchell Plain.

The Crawford Upland is a rugged hilly area developed on alternating sandstones, shales, and limestones of late Mississippian age. These rocks, which overlie the limestones of middle Mississippian age of the Mitchell Plain, are also present in eastern outliers of the Crawford Upland which break up the low, rolling topography of the plain. The middle Mississippian limestones crop out along the valley walls of all the larger streams that lie within the Crawford Upland in the Blue River and Indian Creek drainage basins. For this reason, some of the subterranean drainage heading on the Mitchell Plain flows down the dip of the rocks to resurface along streams in the Crawford Upland.

Blue River enters the Crawford Upland along the Harrison-Washington county line and meanders 55 miles to the Ohio River near Leavenworth, a straight-line distance of approximately 19 miles. Indian Creek within the Crawford Upland meanders 19 miles to travel 8 miles straight-line distance. In addition to the present-day meanders, there are abandoned meanders and associated meander cores which indicate that the route was longer in the past than at present. There are also several abandoned meanders along Buck Creek, which flows entirely within the Mitchell Plain. The prominent alluviated meander at the mouth of Buck Creek (fig. 1) may have been formed by the Ohio River during an earlier erosion cycle. The Ohio River does not exhibit the tight meander pattern of Blue River and Indian Creek, but like these streams, its valley is wider within the Mitchell Plain than in the Crawford Upland.

The meandering pattern of these streams was probably inherited from streams of an older erosion cycle established at a higher level. The primary evidence of a drainage system established at a base level higher than the present one is a group of accordant terraces, abandoned meander loops, and hanging valleys 70 to 130 feet above the present streams. The strath remnants are characteristically small karst plains covered with varying thicknesses of terra rossa and loess. Stream-borne iron-stained pebbles, angular chert fragments, and subrounded geode fragments are found in small patches or as scattered pieces. All these erosion-level remnants are accordant in grade from the mouths of Blue River and Indian Creek to the Mitchell Plain.

The accordant karsted strath terraces along Blue River are here named the Blue River Strath (fig. 2A). The bedrock terrace within the meander core (sec. 26, T. 3 S., R. 2 E., Leavenworth Quadrangle) at Wiseman Riffle lies approximately 130 feet above Blue River. The abandoned valley containing Moberly and ending north of Harrison Spring lies about 110 feet above Blue River (NE¼ sec. 18, T. 3 S., R. 3 E., Depauw Quadrangle). This valley extends eastward onto the Mitchell Plain (fig. 2B). Southwest of Buzzard Roost Hill (secs. 34 and 35, T. 2 S., R. 2 E., and secs. 2 and 3 T. 3 S., R. 2 E., Milltown Quadrangle) the karsted bedrock terrace representing the Blue River Strath covers an area of half a square mile and lies about 90 feet above Blue River. The Blue River Strath is about 65 feet above Blue River at Totten Ford Bridge, where an abandoned karsted valley extends eastward onto the Mitchell Plain (fig. 2C). A bedrock terrace (NE¼ sec. 24, T. 1 S., R. 2 E., Fredericksburg Quadrangle) just east of Radcliff Springs lies about 60 feet above Blue River. The differences in elevation

indicate that the Blue River Strath has an accordant level with a slighter grade than that of the present Blue River. Except for a few places where either cutoffs or diversion has occurred, Blue River now flows in a valley within the valley of the Blue River Strath.

Valleys that extend eastward from Blue River and Indian Creek through the Crawford Upland into the Mitchell Plain and that do not now contain a through-flowing surface stream are former tributaries which have lost their surface waters to subterranean channels. The valley floors contain numerous sinkholes and a cover of terra rossa and loess but do not contain prominent dry beds to serve as temporary surface routes for floodwaters. The waters which divert to underground routes along the valleys appear to resurface near the ends of the valleys along Blue River or Indian Creek, as karst springs, for example, Harrison Spring or Stoner Spring (fig. 1). These springs tend to be located near the base of the hanging valley and along the updip side of a meander loop. Karst springs are also situated at the termini of several hanging valleys which do not extend headward onto the Mitchell Plain, but which rather head along the east margin of the Crawford Upland.

Profiles constructed along the valleys show the pre-karst drainage level and the gradient of the valley (fig. 2). The elevations of the downstream ends of the hanging valleys are comparable to those of strath terraces along Blue River or Indiana Creek near the end of the valley. The gradients of the straths in the lower part of the valley are similar to those of the Blue River Strath, but they become steeper towards and within the Mitchell Plain. This steepening indicates the headwaters of the former drainage basin. The drainage basins of the karsted valleys extended onto the Mitchell Plain, where they adjoined each other or the drainage areas of Blue River, Indian Creek, or Buck Creek, which were established at similar levels. The character of the gradients of the Blue River Strath and some of the abandoned valleys is shown on the profiles.

The Blue River Strath and equivalent strath terraces along Indian Creek and Buck Creek represent the stream system which downcut part of the Mitchell Plain to its pre-karst surface. This stream system consisted of three large streams, Blue River, Indian Creek, and an Ohio River comparable in size to the present Blue River, and five or more small streams which had eroded headward through the Crawford Upland onto the Mitchell Plain. The planation of the limestone bedrock was most likely by both subaerial and subterranean erosional processes.

There are some caverns which formed at elevations higher than the Blue River Strath in the Crawford Upland and in some of its outliers on the Mitchell Plain. Several of these, notably Pitman's Cave, Ragain's Cave and Howard's Cave (3) lie slightly above the level of the Mitchell Plain but were probably developed at grade with the Blue River Strath. The karst features on the remnant surface of the Blue River Strath and on accordant parts of the Mitchell Plain have developed at grade with a base level lower and younger than that of the strath. This new base level enabled surface waters to descend joints and flow laterally at the water table along bedding planes in the limestone, generally downdip, to surface outlets along the major entrenched streams.

The Blue River Strath is at least 200 feet below and is therefore younger than the erosion level of the Lexington or Highland Rim Peneplain which existed during the early Tertiary. The loess which covers the Blue River Strath is probably of Pleistocene age, and the strath lies considerably higher than Pleistocene erosion levels thus far described, particularly the maximum downcutting of early Pleistocene age called the "deep stage" (4) (fig. 2A). Thus the strath is probably pre-Kansan, perhaps pre-Nebraskan in age. If the age assignments of other erosion levels and events are correct, the Blue River Strath must represent a latest Tertiary or earliest Pleistocene drainage system. The strath appears to represent a base level that was of regional significance in the Mitchell Plain and its correlative Pennyroyal Plain of Kentucky. It occupies a position similar to that of the Parker Strath, which has been described as part of the preglacial drainage of the Teays in Ohio and West Virginia (1) and in northern Indiana (4).

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