Plateau Surfaces of the Ozarks

James Harrison Quinn

University of Arkansas, Fayetteville

Follow this and additional works at: http://scholarworks.uark.edu/jaas

Part of the Physical and Environmental Geography Commons

Recommended Citation
Available at: http://scholarworks.uark.edu/jaas/vol11/iss1/8

This article is available for use under the Creative Commons license: Attribution-NoDerivatives 4.0 International (CC BY-ND 4.0). Users are able to read, download, copy, print, distribute, search, link to the full texts of these articles, or use them for any other lawful purpose, without asking prior permission from the publisher or the author.

This Article is brought to you for free and open access by ScholarWorks@UARK. It has been accepted for inclusion in Journal of the Arkansas Academy of Science by an authorized editor of ScholarWorks@UARK. For more information, please contact scholar@uark.edu, ccmiddle@uark.edu.
PLATEAU SURFACES OF THE OZARKS

James Harrison Quinn
University of Arkansas

The Salem, Springfield, and Boston Mountain plateaus(2) form three step-like surfaces of the Ozark highland in Northwest Arkansas, occupying a belt 65 miles wide, and extending from the Oklahoma border eastward across the highland.

The lowest and northernmost of the surfaces, the Salem Plateau, stands at an elevation of about 250 feet on the east, rises to 1,250 feet on the west, and has been intricately dissected. The Salem Plateau is bordered on the south by the Eureka Springs escarpment with a maximum height of 400 feet.

To the south of the Eureka Springs escarpment is the Springfield Plateau which stands from 1,000 to 1,500 feet above sea level. Erosion remnants on the surface stand 250 to 500 feet higher, but the Boat Mountain group rises to 2,250 feet — about 750 feet above the level of the plateau.

The north edge of the Springfield Plateau is dissected by headward erosion of streams. The south border has numerous buttes and spurs. Large areas of the plateau are gently undulating. In most places the relief is less than 100 feet.

Valleys on the plateau are broad and shallow. Formerly, some were deeper, but the old channels have been filled with locally derived gravel. These valleys change to sharply incised, V-shaped gulleys near the escarpments.

The Springfield Plateau is separated from the Boston Mountain Plateau to the south by the Boston Mountain Escarpment, which has a maximum height of 800 feet.

The Boston Mountain Plateau is nearly destroyed, but the mountains are still flat-topped, and in a few places are surmounted by erosion remnants which

*Presented before the Geology Section of the Arkansas Academy of Science at the Fortieth Annual Meeting, April 20, 1956.
PLATEAU SURFACES OF THE OZARKS

rise a few hundred feet higher.

The trunk streams of the area are the White and Illinois Rivers. The White flows north and east, thence southeast to the Arkansas. The Illinois flows west to the Arkansas in Oklahoma. The divide near Springdale, Arkansas is only about 3 miles wide. Both streams are remarkably sinuous; their tributaries are equally straight and short.

The soil profiles of all three surfaces are similar in their stage of development. They are also difficult to evaluate because all are capped with a few inches to a few feet of virgin or reworked loess, depending on their topography.

In the V-shaped tributary valleys there is little or no expression of a soil profile and no loess.

Some fossil mammal remains have been recovered from the plateaus. One of those is a tooth of Onager fraternus, slightly waterworn and presumably from gravel, recovered from a well near Bentonville. Another is a tooth of Mammut americanum found in the bed of Osage Creek, in Benton County T. 18 N., R. 32 W., S. 35, by Mr. R. R. Guthery. The Onager tooth belongs to a much earlier episode of deposition than does the mastodon tooth. Onager fraternus is known in North America from Sangamon and younger deposits. The tooth does not release a "burned bone" odor on ignition. The mastodon tooth releases the odor and is of post-Wisconsin age.

Near the foot of the escarpment in a number of places on the Springfield Plateau there are rock-cut sloping surfaces covered with a veneer of gravel. Fragments are large and angular nearest the escarpments, but diminish in size and become round farther away. The gravel veneer is covered with a layer 2-4 feet thick of fine material, chiefly reworked loess. These surfaces represent pediments still retaining their layers of pediment veneer.

The surfaces have been considered peneplanes or partial peneplanes by earlier workers. At the turn of the century Purdue, (8) following the fashion of the time, attributed the plateau surfaces to peneplanation and believed that they represented a single episode and had subsequently been divided by faulting. Hershey (4) argued for two episodes of peneplanation and considered the Boston Mountain surface as Cretaceous in age. Subsequent writers have followed the assumption of these authors that

http://scholarworks.uark.edu/jaas/vol11/iss1/8
the surfaces are the product of peneplanation. All have followed the Davisian concept of land form development. Davis(3) recognized a difference between the development of land forms under arid and humid conditions and recognized the fact that climates are subject to change (ibid. p. 298). Davis also recognized (ibid. p. 331) that glacial periods probably correspond with times of more moist climate. In his later works Davis discounted the effects of Pleistocene climates and thought that climatic changes (beyond these ephemeral accidents) is a product of the slow wearing away of mountain ranges. In other words he thought that climate changes are geared to the erosion cycle. Otherwise his concept of youth, maturity and old age would be inapplicable.

Actually there is no evidence in the Ozark region to support the concept of peneplanation. There is abundant evidence to support the concept of pediplanation, as the process which has produced the plateau surfaces.

The escarpments separating the surfaces are very irregular. Spurs and isolated erosion remnants occupy divides between streams. The isolated remnants are steep sided, but do not differ lithologically from the strata which once encompassed them. They are, in fact, buttes, not monadnocks. The broad shallow valleys of the plateaus, the pediment-like surfaces at the foot of escarpments, and gravel deposits on the surfaces are products of land form development under arid conditions. The V-shaped valleys trenching the edges of the escarpments necessarily were cut under a different and more humid set of conditions.

The most compelling evidence for pediplanation is indicated by the similar soil profiles of the surfaces. They are all equally immature, in depth of development and depth of weathering of bed rock. This must mean that these surfaces have been deeply planed at the same time and that they are the same age. This is not possible in the process of peneplanation. It is possible in the process of pedimentation. The system operates precisely like the engineering method of open pit mining. A pit is opened to a given depth and enlarged by working back the walls. As soon as there is enough room,
PLATEAU SURFACES OF THE OZARKS

A second level is begun -- the walls of both being worked back simultaneously. When the inner pit is large enough, a third is opened so that there results a series of terrace levels all being worked back at the same rate. As the wall above retreats a surface of planation is left behind to be consumed by the advancing wall below. Thus, although the levels represent earlier and later times of origin, the surfaces themselves have the same age.

Otherwise the "oldest" and highest surface of the Ozarks should long since have been destroyed while the youngest should be best preserved. In fact, the lowest and "youngest" surface, the Salem, is said to be the most dissected. (2)

It is accepted without equivocation that pedimentation is a process which occurs under arid conditions. It is equally true that stream entrenchment or dissection takes place under humid conditions. (6, 7) The two processes are not compatible, and although there are no sharp breaks in climatic behaviour, which would lead one to assume the one type of topography should grade imperceptibly into the other, they do not do so. The controlling factor is not directly climate, but plant cover, and here the breaks are sharp and clear. In general, more than 20 inches of rainfall will produce forestation which is the most effective plant cover. Additional amounts of rainfall do not increase the effect. But, if rainfall is reduced below the amount necessary to support forest by as much as an inch or two, the forest cover is replaced by less effective grass, and a marked change in erosion rates follows.

It is therefore obvious that escarpments which are engendered by valley cutting are a product of the humid cycle which likewise furnished abundant moisture to nourish glaciation. It is equally clear that pedimentation is the product of the arid cycle which likewise starves the glaciers.

It is also to be remarked that multiple erosion surfaces can only be formed as a product of climatic alternation. There is no mechanism in the process of arid erosion to form scarps.

Finally, by the simple process of working backward, we can deductively assign ages to the origin of the surfaces and escarpments, relative to the humid glacial and arid interglacial stages of the
Pleistocene.

The youngest extensive land form is the V-shaped valleys cut into the borders of the plateaus. These are not now active. They must have been cut during the Wisconsin glacial stage (there is, however, little sign of terracing). The lowest extensive surface of planation was initiated during the Sangamon interglacial stage.

Minor alluviation = Altithermal (Dry)
V-shaped valleys = Wisconsin (Wet)
Salem Plateau = Sangamon (Dry)
Eureka Springs Escarpment = Illinoian (Wet)
Springfield Plateau = Yarmouth (Dry)
Boston Mountain Escarpment = Kansan (Wet)
Boston Mountain Plateau = Aftonian (Dry)
Slopes of the Boston Mountain Buttes = Nebraskan (Wet)

Additional evidence for the Pleistocene age of the surfaces and the fact that diastrophism is not involved in their development, as would be necessary if they are partial peneplanes, is furnished by the physiography of the Arkansas River. The Arkansas flows between the Ouachita highland on the south and the Boston Mountains on the north. The highest point in the entire region is Mt. Magazine, with an elevation of 2,800 feet. Mt. Magazine is located in the valley 15 miles south of the river. It is approximately on a line trending northeast along the middle of the Ouachita-Ozark highland. This highland was formerly continuous (in pre-Pleistocene time) and the present Arkansas is the product of piracy of former drainage west of the highland. (Fig. 1) Streams on both the western and eastern flanks of the highland entrenched themselves and eroded headward until they met at the divide of the highland. Since the eastward flowing stream had a much lower base level and may be assumed to have received a greater amount of precipitation, and to have eroded its valley faster, the westward flowing stream came to be reversed, and the eastward flowing branch extended all the way across the highland. The Arkansas Valley nar-
Figure 1

Schematic diagram of Ozark-Ouachita region indicating the gross drainage pattern in Kansan time before the Arkansas River had completed its headward erosion into the drainage system west of the highland. Sedimentary rocks of the Ouachita region are quartzites, slates and novaculite. Those of the Missouri Ozarks, chert, sandstone and massive limestones. These rocks may have retarded the headward encroachment of the Ouachita and White River. The Arkansas is entrenched in the softest rocks of the region, lower Pennsylvanian sandstones, and shales mostly of post-Atokan (Pottsville) age. (R.A. Ault, University of Arkansas Graduate School, artist.)
rows in the vicinity of Mt. Magazine and widens progressively to both west and east. This fact together with the position and height of Mt. Magazine is otherwise difficult to explain. The highest surface, the Boston Mountain Plateau, seems to have extended across the valley region. Thus the highland must have been in essentially its present position and at, or higher than, its present elevation at the beginning of Pleistocene time. Development of the modern Arkansas River was completed before Sangamon time, since gravel terraces along the Arkansas, attributable to alluviation during Sangamon time, contain Permian Fusulinida which are found in northeastern Oklahoma, and were brought down the Verdigris and Arkansas Rivers into Arkansas.

The mechanism of planation and age assignments given here furnish the most reasonable, logical and simple explanation for the present physiography. Only one reevaluation of our cherished concepts is required, that in the past we can have had both arid and humid conditions in the same place. I would not go so far as King(5) in suggesting the peneplane is an imaginary land form. I would suggest, rather, that the great majority of the surfaces we see today are the product of Pleistocene climatic cycles. It follows that if this can be established, it may be possible to contribute a great deal of information to the patterns of Pleistocene climate, which will help us to a better understanding of the glacial mechanism.

LITERATURE CITED

(4) Hershey, O., 1902. Boston Mountain physiography, Journal Geol. 10:160-165
PLATEAU SURFACES OF THE OZARKS

