Physiography of the Boston Mountains, Arkansas
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PHYSIOGRAPHY OF THE BOSTON MOUNTAINS, ARKANSAS [1]

THE highlands of Arkansas lie in the northwestern part of the state, and comprise about half its area. They are divided, physiographically, into a north and a south part by the valley of the Arkansas River. They are also divided structurally into the same parts, the former being a region of horizontally-bedded rocks, somewhat disturbed by faulting and folding, while the latter, known as the Ouachita Mountains, is distinctly a folded region.

This northern division of the Arkansas highlands, with its westward extension into Indian Territory, constitutes the southern part of the Ozark region.[2] In Arkansas, it is divided into a low and a high part, the former extending northward into Missouri, and passing, along its southern border, into the latter, by an irregular but bold escarpment from 500 to 1000 feet high.

It is this latter region that is known in Arkansas as the Boston Mountains. Including that part which lies in Indian Territory, its total length is about 215 miles, about 170 of which is in Arkansas. Its average width approximates 35 miles. On the south, it passes into the valley of the Arkansas River by steep slopes, though less precipitous than those on the north.

These mountains are by far the highest part of the Ozark region as well as the most picturesque. Their highest point, so far as determined, is some miles east of the town of Winslow, on the St. Louis and San Francisco railway, where the altitude is 2,250 feet.[3] From this region of highest elevation, they

[1] Read before Section E of the American Association for the Advancement of Science at the Denver meeting, August 1901.

[2] The Ouachita Mountains have been included by some writers with the Ozarks; but because of the great structural and topographic differences in the two regions, to say nothing of the probable historic differences, this is manifestly wrong.

[3] Topographic map United States Geological Survey, Winslow quadrangle.

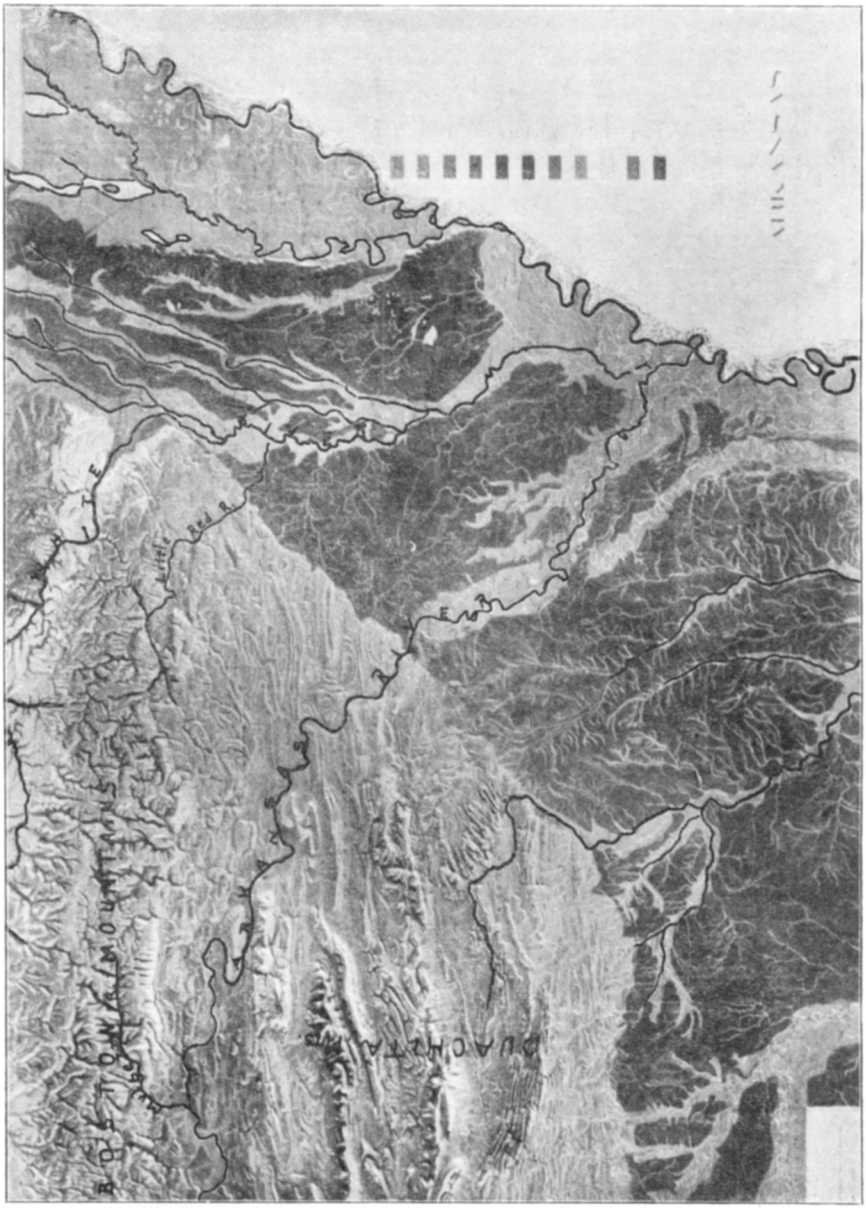

FIG. 1.—Photo from Branner's relief map of Arkansas.

gradually fall off to the east, sinking below the Tertiary deposits just west of the St. Louis, Iron Mountain and Southern railway and south of White River; also from this region of highest elevation, they fall off westward to the Grand River in Indian Territory.[1] It will be seen that the east-west line along the crest of these mountains forms a gentle arch in the middle. Structurally, in the western part of Arkansas, these mountains are a broad, flat anticline, the strike of which is east and west. According to the geologists of the Arkansas Geological Survey, it appears that the extreme eastern part of the region is monoclinal in structure, with the dip to the south.[2]

With the exception of the Illinois River in the western part of the state, the drainage of the region is northward and eastward into White River, and southward into the Arkansas. The direction of the streams has been determined by the slopes incident to the uplift, modified in some cases by faulting and flexuring. The effect of the latter upon Little Red River and neighboring streams has already been noted by Professors Newsom and Branner.[3] The westward course of the Mulberry River has been determined by a fault. Detailed work of the region would doubtless disclose numerous other similar examples.

The drainage of the region is that intermediate between youth and maturity. The streams are vigorous, and have completely dissected the plateau by the formation of gorges from 500 to 1000 feet deep, thus producing a very rugged topography over the whole region. Between these gorges the slopes often meet, forming more or less rounded hills; but more frequently the intervening area is occupied by flat-topped, sandstone-capped hills of limited extent.

The tributaries of both the Arkansas and the White rivers have worked their way back to, and in many cases, far beyond

[1] DR. N. F. DRAKE, in *Proc. of the Am. Phil. Soc.*, Vol. XXXVI, No. 156, p. 332.

[2] NEWSOM and BRANNER, "The Red River and Clinton monoclines, Arkansas," *Am. Geologist*, Vol. XX, July 1897, pp. 1–13.

R. A. F. PENROSE, JR., *Ark. Geolog. Surv.*, Vol. I, 1890; section with pocket map.

[3] *Loc. cit.*

the original water divide of the plateau, making the water divide as it now exists, a very zigzag line. In the western part of the state, the south-flowing streams are the stronger, and as a rule are robbing the White River basin of territory in this locality. Further east, in the middle portion of the region, the north-flowing streams are the stronger, and seem to be encroaching upon the drainage area of the Arkansas, while in the eastern part, the south-flowing streams head very near the north escarpment of the plateau.

The rocks of the region are mainly unmetamorphosed sandstones and shales, those at the base being of Lower Carboniferous age, and those at the top belonging to the Coal-measure series. These alternating hard and soft rocks have produced the terraces on the hill slopes, which are so characteristic of dissected regions of horizontal strata. As these terraces are often of considerable width, and are favorable horizons for springs, they are inviting to the farmer, and can be located miles away by the small farms on the mountain sides.

The low region to the north of the Boston Mountains is one of great denudation. From its northeastern part, all the rocks have been removed above the Ordovician, leaving those exposed at the surface. West and south of this is a region from which the Upper Carboniferous rocks have been removed, leaving those of Lower Carboniferous age at the surface. Standing up prominently on the latter are numerous hills of circumdenudation, composed of remnants of the horizontal strata of the Boston Mountains, and serving as living witnesses to their former extent. The height of these outliers very closely approximates that of the plateau of which they were formerly a part. This uniformity in height between the various parts of the dissected Boston plateau and its outliers suggests a peneplain, and herein lies the physiographic problem of the region.

In a region of folded or inclined strata the determination of a peneplain becomes a question of comparative ease, for in those cases denudation will have reduced both hard and soft strata to practically the same level, the peneplain intersecting

strata of all degrees of hardness. But in the case of horizontal strata undergoing base-leveling, the conditions are quite different, for then the peneplain conforms to the hard stratum or strata that happen to be near sea level. If such a region be subsequently elevated, the streams are revived, the region dissected, and the former peneplain represented by the tops of the hills, which would still be capped by the hard strata that were conformable with the peneplain before the region was elevated. Now this is exactly the structural and topographic conditions of the Boston Mountains and their outliers. But it happens that these are also the structural and topographic conditions that would prevail in a region of horizontal strata that has been elevated from beneath the ocean and is undergoing the process of base-leveling for the first time. So the problem presents itself as to which condition prevails in the Boston Mountains, and unfortunately criteria for its solution are largely if not wholly wanting.

Ordinarily, for the determination of a peneplain we look to the streams. In such cases, as is well known, the streams are winding, and flow in more or less steep-sided, symmetrical valleys, which are themselves cut down in wider valleys. In the Boston Mountains there is no such evidence of a peneplain. The streams of the region are all young, with the characteristic steep-sided gorges of such streams. So far as the writer has been able to observe, there is nothing in the region indicating an uplift since the present streams came into existence. Their valleys are relatively wide at their mouths, and gradually decrease in width back to their sources, as would be expected of streams cutting into a plateau of horizontal strata. The slopes are undisturbed by terraces, excepting such as those mentioned above, which are due to structure. Along the southern base, the oldest of the streams have reached the temporary base-level of the Arkansas River, and meander somewhat, but none of them to any great extent.

It follows that evidence of a former base-leveling, if there be such, must be looked for elsewhere than in the streams. A

recent writer[1] claims that the tops of the Boston Mountains represent a peneplain, and cites as evidence the fact that they correspond very closely in height with the Ouachita Mountains south of the Arkansas valley. This evidence is given on the assumption that the rather uniform height of these mountains represents a peneplain; but this is a hypothesis far from being established. Mr. L. S. Griswold, in his work on the novaculite region of Arkansas, encountered the problem of the nonconformance of some of the main streams of the region to the structure and topography, to account for which he presents the theory of a post-Carboniferous base-level, on which was subsequently deposited Cretaceous strata.[2] If the present writer correctly interprets Mr. Griswold, he believes the south-flowing streams, which form water-gaps in some of the highest mountains of the region, are superimposed streams, their courses having been determined by the slope of the Cretaceous area after elevation. Mr. Griswold does not claim that the evidence of this is conclusive. It is the opinion of the present writer, from somewhat limited observation, that the even crests of the Ouachita Mountains are due to structural and lithological conditions and not to base-leveling. But were it established that they represent a peneplain, the fact that the Boston Mountains closely agree with them in height does not argue a peneplain for the latter. The one is a folded area, and the other an area of horizontal rocks (Fig. 2). Erosion in the one has resulted in wide, anticlinal valleys through which flow sluggish streams, while erosion in the other is in its early stages. It would seem to follow that the time of elevation of the one region is far antecedent to that of the other, and consequently the correspondence in height between the two only accidental.

If, however, we look to the north of the Boston Mountains, we find conditions which seem to throw some light upon the subject. As has already been said, this is a region of great denudation. Its general elevation is from 700 to 1000 feet

[1] O. H. HERSHEY, *Am. Geologist*, Vol. XXVII, No. 1, pp. 25 *et seq.*

[2] *Ark. Geol. Surv.*, 1890, Vol. III, pp. 220.

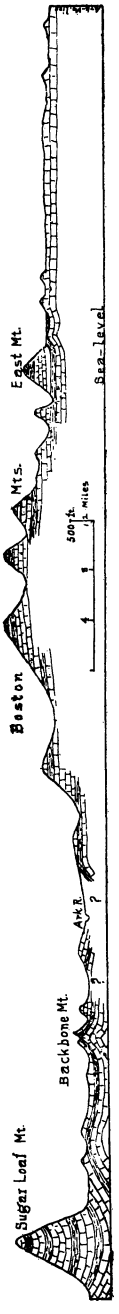

FIG. 2.—North-south section of the Boston Mountains and adjacent regions, near Arkansas-Indian Territory line.

lower than that of the Boston Mountains. Its streams are mature, the valleys comparatively wide, and the topography in general presents the aspect of much greater age than that of the Boston Mountains. Professor C. F. Marbut, in discussing that part of this region which lies in Missouri,[1] claims that it was base-leveled in early Tertiary times, and the present cycle of erosion was instituted by an elevation which dates from middle or late Tertiary times. Be that as it may, the question as to whether the region to the north of the Boston Mountains ever suffered denudation to the extent of base-leveling does not particularly concern us here. The fact of interest is that the denudation of the extensive region to the north has been very great and the topography is old, while that of the Boston Mountains is limited and the topography young.

It would appear that this difference in topography cannot be attributed to the massive beds of sandstone at the top of the Boston Mountains, for these same beds, while they have doubtless had a great deal to do with preserving the region, formerly extended over much if not all the denudated area to the north. Besides, if we attribute the preservation of these mountains to the character of the rocks composing them, we are encountered by the question as to why erosion has been so extensive to the north of the region, removing the rocks over a large area, leaving only here and there hills or circumdenudation, while in the southern part adjacent to the Arkansas valley it has scarcely begun.

I am able to account for the great difference in the stages of erosion in the two regions only by conceiving the Boston Mountain area to have been at a lower elevation than the area to the north during

[1] *Mo. Geol. Surv.*, Vol. X, pp. 27–29.

the time the extensive denudation was going on over the latter. So low must it have stood that the strata now composing their summits suffered but little erosion, while the same beds extending northward suffered much because of their greater height. If this be true, the actual amount of degradation suffered by the Boston Mountain region is indeterminable; but as there was more or less of it, and the region stood at a low level, it would be considered a peneplain. The elevation, which must have occurred in late Tertiary or in post-Tertiary time, was greatest along the present east-west axis of the plateau, gradually decreasing to the northward, and changing the region from a low, monotonous plain to a plateau approximating 2,500 feet in height, greatly modifying the former drainage and instituting that of the present.

Aside from the difference in topography between the region under discussion and the one to the north, the writer cannot at present claim very great support for the idea herein presented. There are, however, some other facts that seem to lend the hypothesis support. (1) The region being on the border of the Ozark uplift, it is probable that during the greater part of its history it lay at a low level and consequently suffered comparatively little from erosion. (2) The outliers of the Boston Mountains to the north are as a rule lower than the main plateau, though capped by the same rocks, thus indicating an axis of elevation to the south of the outliers. (3) The eastward course of White River and its tributaries may be due to their having been diverted from what would seem a more natural southern course, at the time of the uplift.

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