BOSTON MOUNTAIN PHYSIOGRAPHY.

UPON a careful perusal of Professor A. H. Purdue's recent article on the "Physiography of the Boston Mountains, Arkansas,"[1] it will appear that he dissents from the opinion that there is represented in the summit of that range a plain of denudation older than that which is usually supposed to be widely developed over the Ozark plateau north from the Boston Mountain; and this interpretation he bases upon comparison of the erosion forms characterizing the two areas, finding that the lower and heretofore supposedly "newer" region (considered from the standpoint of the physiographer), in reality has by far the older type of topography. It seems to the present writer that Professor Purdue has overvalued some of the evidence and minimized or totally ignored other factors which may have an important bearing on the question at issue.

Ever since my paper on the "Peneplains of the Ozark Highland"[2] left my hands I have been conscious of a slight discrepancy in my interpretation of the topographic development of west-central Arkansas, and I wish to take advantage of this opportunity to set it aright.

In identifying the truncated summit of the Boston Mountain as a remnant of the same supposed dissected "Cretaceous" peneplain, as is indicated in the summits of the Ouachita ranges south of the Arkansas river, I dwelt too strongly on the general correspondence in height of the two systems of ridges, and later vitiated the conclusion based thereon by developing the probability that the present elevated condition of the Boston Mountain region is largely due to differential uplift in the early part of the Quaternary era.

Dr. C. R. Keyes, in his article on the "Composite Genesis of the Arkansas Valley Through the Ozark Highlands,"[3] seems to

[1] JOUR. GEOL., Vol. IX, No. 8, p. 694.

[2] *American Geologist*, January, 1901, p. 21. [3] JOUR. GEOL., Vol. IX, No. 6, p. 486.

appreciate the true significance of the evidence, and the figure which he gives on p. 487 is virtually in accord with my present conception of the subject. It is believed (for the same reason that a dissected peneplain is recognized in the summits of the Appalachian ridges) that the summits of the Ouachita mountains are remnants of an old plain of denudation (whether in age Cretaceous or early Tertiary matters not), and that this plain would descend rapidly to the axis of the Arkansas valley had it not been totally destroyed over that broad structural and topographic depression; and that then it would rise northward because of a monoclinal folding inaugurated in early Quaternary time, and perhaps continuing today. The question is, Would this projected plane coincide with the summit of the Boston Mountain?

Let us eliminate later deformation and straighten out the supposed lower or "main Tertiary" plane of erosion baselevel. Our theory supposes that the earlier or "Cretaceous" baselevel plane would first become distinctly differentiated from the later in southern Missouri, and the difference between them would have increased to about five hundred feet on the northern edge of Boston Mountain. Continued to the first ridge of the Ouachita system, the difference between the two planes might be expected to be one thousand feet, but through the concavity common to the border of all symmetrical dome-like uplifts it would be natural to expect an increase to at least the present difference in level of the planes at the summit and base of Sugar Loaf Mountain, about 1200 feet, I believe.

But Professor Purdue has raised a question of the validity of this interpretation by his erosion studies, the pertinence of which cannot be ignored. He says, in reference to the Boston Mountain region:

> 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.

Of the lower plain to the north, he says:

> This is a region of great denudation. . . . . 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.

"Youth" and "maturity" as applied to streams and valleys are terms relating to types and not to age as measured in years. The topography and drainage of a land never greatly elevated, and possessed of a humid climate and soft formations may be ever so senile in type and yet no older in years occupied in its development than another region characterized by immaturity of its physiographic features. This is an axiom of the science of physiography. The less mature character of the drainage and erosion forms of the Boston Mountain region than of that on the north does not necessarily militate against a reference of the development of its summit plain to an earlier cycle of erosion.

Some of the causes which have tended to bring about this result are as follows:

Boston Mountain owes its prominence and preservation as a residual on the "main Tertiary" peneplain largely to the resistant properties of the Upper Carboniferous sandstone which enters so largely into its composition. On the south, the Arkansas valley was developed on a belt of soft shales and all traces of residuals were swept away. On the north, the elevation of the land was less, the streams soon cut down to baselevel and could devote a large part of the cycle of erosion to widening their valleys. The Boston Mountain was on the main divide between the White and Arkansas river systems, and only very small streams operated on it while the country on either hand was being ground away by powerful trunk streams. The latter developed meandering courses indicating maturity, but we could hardly expect to find similar winding courses in the small headwater streams of the main divide.

The evidence of youth in the Boston Mountain valleys is somewhat deceptive, especially on the southern slope. Here I

recognize valleys of several cycles trenched beneath each other and coalescing so as to be apparently the product of a single cycle of erosion. (I am using the term "cycle" as referring to the time between uplifts with rejuvenations of the drainage.) Eliminate all those portions of the valleys which are below the supposed "main Tertiary" baselevel plane, say five hundred feet below the general summit level of the mountain, and much of the youthfulness will disappear; the valleys remaining will be comparatively broad and flat-bottomed.

Another indication of immaturity recognized is the flat summits. This feature is maintained by the rather resistant sandstone strata capping the hills and its importance is exaggerated by its abnormal character.

If the summit plain of the Boston Mountain was not developed anterior to that of the lower county on the north, it must have been elevated by faulting. The northern face of the Boston Mountain is "an irregular, but bold escarpment from five hundred to one thousand feet high." This is entirely too sinuous to be a degraded fault scarp. Great promontories project out into the plain country on the north. The phenomena are characteristically those of differential erosion. If a fault with a throw of five hundred or one thousand feet existed, it must have dislocated the Upper Carboniferous sandstone in such a conspicuous manner as would long since have attracted attention. In short, I cannot see any escape from the conclusion that the Boston Mountain was a residual on the baselevel represented by the plain to the north—the Ozark plateau.

The criteria on which I would base the recognition of a dissected peneplain on the nearly horizontal rocks of the central Mississippi region are: (1) many of the summits must be truncated; (2) these flat summits must fall into a single plane, only very slightly tilted; (3) the plane must pass across diverse formations without deformation; (4) the plane must to some extent bevel the edges of the slightly inclined strata; and (5) the dissected plain must be extensive enough to make it improbable that it was developed by marine erosion. Such other

phenomena as meandering stream courses and monadnocks are valuable adjuncts, but not essentials. How do these principles apply to the Boston Mountain region?

In arriving at the most natural explanation of the uniformity in height of the Boston ridges, six hypotheses may be briefly examined: (1) That it is a plain of aggradation of Upper Carboniferous age which remained intact until very late geologic time because of having stood virtually at sea level. This is calling into play a possibility which is not a probability. From what is known of the history of the continent in post-Carboniferous time, it may be considered unnatural. However, even allowing that such a strange coincidence may have occurred, I should still claim the summit plane of Boston Mountain as representing a baselevel of subaerial erosion, an appendage to a true peneplain. (2) That it was planed off by marine erosion and a thin sheet of Cretaceous or Tertiary sediments deposited on it. A submarine shelf, twenty miles in width, would have a considerable thickness of sediment resting on its seaward portion, and some remnants should remain on the flat-topped hills. If the submergence was very short, I should claim the reduction of the area to a plain condition to have been virtually the work of subaerial denudation, very slightly aided by marine action. As a matter of fact, there is no collateral evidence of such submergence in post-Carboniferous time and the drainage system is against it. (3) That the uniformity in height of the separate ridges which together constitute the Boston Mountain can be attributed to the intersection of the slopes of valleys having a common baselevel is an untenable position because most of the ridges have truncated summits. (4) The conditions of the soil, climate and amplitude of elevations are not such as to give value to any argument based on differential protection by vegetation. (5) That it is a structural plain resulting from the unequal resistant properties of the Carboniferous strata eroded. This implies that there be strict parallelism between the plain and the bedding of the rocks, for studies in the western states where this agency has had full play in the production of topographic forms, make

it certain that there must be no general beveling of hard and soft layers. Professor Purdue says:

> 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.

The dissected plain is also slightly tilted and slightly bowed, but I invite someone to show that it is strictly parallel to the structure. Specific data on this point are wanting. I believe that the plain actually bevels the slightly inclined strata, and if the summit-plane of the outliers on the north be admitted into the argument, I know that it does. (6) By elimination, the peneplain hypothesis comes to the front as that which furnishes the most natural explanation of the phenomena observed and violates no established principles of physiography. I believe the peneplain character of Boston Mountain is as firmly established as that of any other recognized dissected peneplain in eastern America. It is not proved and perhaps never will be as proof is made in other departments of science. A strong suspicion now existing that an ancient peneplain is represented may be strengthened as more precise data are recorded and in time the critics may cease opposition. At present their activity is desirable as stimulating the collection of evidence.

As precedents for disregarding, in the conclusion that the dissected plain at the summit of Boston Mountain has an age greater than that of the "main Tertiary" peneplain, the argument drawn by Professor Purdue from the contrast in stage of maturity of drainage and topography on the two areas, I will mention the plateau of West Virginia with its narrow valleys, standing as a residual on a Tertiary baselevel which in other portions of the Appalachian region has broad basins and mature topography; and the Niagara plateau of northeastern Iowa, rising prominently above a lower dissected plain whose valleys are equally as large.

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