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THE BARABOO REGION OF WISCONSIN*

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THE Baraboo Ridges (Fig. 1) are well known topographic features in south central Wisconsin, thirty miles northwest of Madison. Attractive woods, rocky hills and remarkable gorges, one of which is occupied in part by the picturesque Devil's Lake, have long made the place a favorite summer resort for people living in that part of the state, and even for travelers from more distant places. The Saint Paul Division of the Chicago and North-Western Railway passes through the heart of the district. Trains stop at Devil's Lake, at Baraboo, and at Ablemans, near the north ridge, thus making the region easily accessible. In the summer of 1907 a small grant from the Sturgis-Hooper fund of Harvard University enabled the writer to make a brief inspection of a part of the area.

The geology and geography of the Baraboo region have become more or less familiar through the labors of members of the United States Geological Survey and of the Wisconsin Survey,[†] and, for some years past, excursions have been made to this locality by classes from neighboring universities.

The country, exclusive of the Baraboo Ridges, averages about 1,000 feet in elevation. Two types of topography are presented. To the west and southwest dissection has reached a late mature stage. Drainage is uninterrupted. The larger streams have developed broad flood plains, so wide that the rivers, in their meanderings, touch the valley sides only occasionally. Even the smaller streams have developed flood plains of some width, and in places the intervening uplands have been cut away, leaving extensive areas of relatively low land, with here and there residual masses of unconsumed upland. The surfaces of the uplands themselves have fairly accordant levels, which rise to within 400 or 500 feet of the crests of the South Range, and indicate an earlier peneplaned surface, below which the later dissection has produced a relief of about 300 feet.

To the east and southeast there is little dissection. Depressions with no outlets, swamps and ponds abound and streams are generally sluggish. There are many lesser elevations, usually in the form of rounded hills, but these have no definite relation to the streams. The latter wander aimlessly about in swamps, and have as yet accomplished little in the way

*The writer is indebted to Prof. W. M. Davis for helpful suggestions.

[†]See especially Salisbury, R. D. and Atwood, W. W. "The Geography of the Region about Devil's Lake and the Dalles of the Wisconsin." *Wis. Geol. and Nat. Hist. Surv. Bull. V, Educ. Ser. 1*, 1900.

of making valleys for themselves and draining the surrounding country. Locally some of the streams have cut valleys for short distances. A particularly striking case is furnished by the Wisconsin River, near Kilbourn, where it has cut the beautiful gorge known as the Dells, or Dalles, as it is sometimes called, fifty to one hundred feet deep, in relatively weak

Fig. 1. Sketch map of the Baraboo region modified from Salisbury and Atwood

horizontal sandstones. From this region the Wisconsin makes a wide detour southeastward, around the east end of the Baraboo Ridges, and then returns to a point six or eight miles south of Devil's Lake, where it again bends southward.

The Baraboo Ridges run nearly east and west for about thirty miles, and rise somewhat abruptly from the surrounding lower country. They are heavily wooded and form a marked contrast to the relatively open fields and farm lands north and south. They are divided into two ranges, of which the northern is lower, narrower and less continuous. The South

Range reaches a maximum elevation of 1,600 feet just east of Devil's Lake and falls off gradually toward both the west and the east. The ranges are joined at the eastern end. Both ridges are cut by transverse gorges or passes of wild and picturesque beauty. The Baraboo River occupies the two main openings of the North Range. These are known respectively as the Upper and Lower Narrows, but the latter is too wide to be proportional to the present breadth of the stream. The gorge in the South Range is the largest of the group and is not now occupied by a river. Heavy bands of moraine pass across the northern and southern ends and within the enclosure thus formed lies Devil's Lake with rocky cliffs and crags rising steeply on either hand. A view of this part of the range from the north, together with some of the morainic topography, is shown in Fig. 2.

The ridges owe their present relief to the fact that they are composed of ancient quartzite rocks, very resistant to erosion. These rocks were originally horizontal but are now tilted at varying angles and bear other evidences of considerable deformation. Here and there, on the ridges, occur patches of undeformed, weaker conglomerates and sandstones, like those that underlie the lowlands round about. Similar patches occur in several of the passes, including the Devil's Lake gorge, and in some of the older valleys that do not cut through the ranges. These residual masses, together with the larger body of sedimentary rocks underlying the neighboring region and abutting against the quartzites, show that the ridges, with their included passes and older valleys and all the surrounding country were once covered with sedimentary deposits to a considerable depth—buried, as it were—and that by subsequent erosion they have been exhumed and again laid bare. But the presence of passes in the quartzite ridges before the deposition of the later sediments suggests a long history that bears upon our interpretation of the present physiographic features.

It is not known how deeply these passes were excavated before burial. If they were already developed as transverse valleys, they may represent ancient river courses that became superposed upon the hard quartzites during revival after peneplanation in a previous cycle; for, during the peneplain stage, rivers may meander so widely as to carry their channels over more resistant rocks than those in which they were originally developed. Under such circumstances revival may cause a stream either to be superposed or to change its course. Such an explanation then involves two cycles of erosion; one in which the peneplain was produced and a later one, inaugurated by revival, in which occurred the superposition of the stream and the development of the transverse valley. Another explanation, involving but one cycle of erosion, would account for the development of

transverse valleys by the gradual lowering and shifting of the divides between the heads of opposing streams until at first notches or passes in the ridges were formed and finally the transverse valleys appeared.

The character of the surface, on which the later sandstones were deposited, indicates that an advanced stage of erosion had been attained, for

Fig. 2. Devil's Lake gorge from the north, showing morainic topography

the old distorted rocks of the region, with the exception of the very resistant quartzites, were bevelled and even the latter were reduced to subdued outlines. Thus one stage of peneplanation and possibly two such stages, as suggested above, preceded the deposition of the sandstones. But the latter belong to the Cambrian period so that all this ancient erosion occurred in Precambrian times. During the ensuing long period of sedimentation the ridges and their surroundings became deeply buried. Finally revival again took place and the thick covering was largely removed. This period of erosion has continued until the present day, but the rate has not been uniform. Two well-defined cycles or partial cycles have been recognized and there is some evidence that there may have been still others. This erosion has cleared out the sedimentary fillings of the gorges and may even have deepened the latter and modified the ridges, but it is probable that, in so far as the ridges are concerned, the ancient surface is preserved to us

much as it was at the time of burial and may thus be considered as a fossil landscape of Precambrian times.

In the glacial period the ice covered the eastern part of the ranges and the country north and south of that portion, but it did not reach the western region. This, then, is the reason for the two types of topography previously mentioned. The western and southwestern districts, that so well exhibit the erosion type, are a part of the driftless area into which the ice did not extend, while in the eastern and southwestern area the topography, originally like that farther west, has been masked and modified by glacial drift. The line of separation between the two types is well marked and runs nearly due south from Kilbourn to Prairie du Sac. Where it crosses the ridges it bends eastward, and where it reaches the lowlands it turns westward again, thus showing the retarding influence of the resistant ridge upon the westward-moving ice near its margin. The terminal moraine passes four or five miles west of the city of Baraboo, and the rolling, undulating topography which it produces is well shown near that place. Devil's Lake is the diminished descendant of a marginal lake that occupied an interlobate position in the lee of the eastern part of the South Range (Figs. 1 and 2).

One of the interesting questions raised by the relation of Devil's Lake to the enclosing gorge is what part, if any, the Wisconsin River may have taken in the Preglacial history of the ridges. The eastward deflection of the Wisconsin south of Kilbourn has already been referred to. The Lower Narrows of the Baraboo River are much wider than the Upper Narrows and appear to have been occupied by a more powerful stream than the Baraboo. The Lower Narrows, too, are comparable in size to the gorge in the South Range. Positive evidence is lacking, but it is believed, in accordance with Irving's suggestion, that the Wisconsin formerly flowed through both the Lower Narrows and the Devil's Lake gorge. Then the Baraboo River probably joined the Wisconsin at some point between the two ridges, after passing through the Upper Narrows. The present course of the Wisconsin has, then, been produced by glacial obstruction in the region between Kilbourn and Prairie du Sac. Devil's Lake has been formed by the enclosure, between moraines, of part of the old valley floor.

In the driftless area during Glacial and Postglacial times erosion progressed in normal fashion, the streams degrading or aggrading their valleys as the ratio between carrying power and load increased or diminished. In the glaciated area, on the other hand, Preglacial activities ceased when ice covered the land. Hills and valleys alike were scoured by ice action, and a coating of till, varying in thickness, was spread widely over the

surface, with the general effect of planing off the hills and filling up the valleys. When the ice retired a new surface was exposed, from which most of the earlier drainage lines had been obliterated. In place of the nicely adjusted system of branching and sub-branching valleys, so well seen in the driftless area, the surface of the glaciated area presented a series of broad flat depressions, with many minor hollows and elevations, having no definite relation to each other. Waters gathered in all the depressions, and the streams, partly or wholly displaced from their former channels, were forced to wander from one filled hollow to another over the lowest places in the divides. Since the Glacial Period the streams, usually of slight grade, have been able to do little cutting. Many of the ponds thus formed have been filled or partly filled by the combined action of stream wash and the rapid growth of water-loving plants, but there are still numerous ponds and extensive marshes that have yet to be drained or filled. The Wisconsin River is a notable exception to the general rule, in that it has made deep incisions in the till and cut the beautiful gorge of the Dells.

In the ridges themselves, several streams, having the advantage of steeper grades, have been able to carve for themselves in Postglacial times deep and picturesque ravines. But these are all in their youthful stage, as is shown by their steep-sided, V-shaped valleys, rapid currents and rocky bottoms.

To the systematic physiographer the Baraboo region offers an attractive field, for there, within comparatively small compass, is included a considerable variety of forms well worthy of classification. In the first place there is the ridge itself, a bit of fossil landscape preserved from remote geological times. One of the more recent geographical terms that has received general adoption is the term *monadnock*, a name applied to those hills, which, like Mt. Monadnock, New Hampshire, represent residual elevations of resistant rock in a region eroded nearly to baselevel, that is, in a peneplain. It has been suggested that the name *baraboo* might be applied to those elevations, which, like the Baraboo Ridges, represent ancient monadnocks that have been entirely buried by later sediments and then exhumed.

Superposed rivers have for some time been recognized as in some cases the result of revival in a peneplained region, where rivers, in their broad meanderings, have wandered over harder rocks than those in which their courses were originally developed. It has been seen that the Precambrian passes of the Baraboo Ridges may be examples of ancient superposed river valleys, or of passes developed by opposing streams in a single cycle, subsequently buried and then re-excavated. Some shorter terms for buried and re-excavated, superposed valleys or one-cycle passes would be highly desirable but none have as yet been advanced.

The driftless area has already been described as a region in a late mature stage of development, succeeding peneplanation in an earlier cycle. Its presence in this region and the recognition of its character are valuable aids in the interpretation of the physiography of the neighboring glaciated area. The occupation of the country by ice may be regarded as accidental, in so far as the previous development of surface features was concerned. From the evidence afforded by the driftless area we know that the country now glaciated must have reached a similar stage of development and must have had a well organized system of drainage, adjusted to the given conditions of volume, load and slope. When the ice overwhelmed this territory and finally withdrew, its action had completely disorganized the previously existing, adjusted conditions and had necessitated an entire readjustment of the streams to their work, just as in volcanic regions it sometimes happens that showers of dust and streams of lava greatly modify the surface of the country and force the rivers to readjust themselves. The physiography of the glaciated area is not properly understood if the latter is regarded as merely in a youthful stage of development. The idea of readjustment must also be considered, since the process of development has been different from that in a youthful region not glaciated. In the Baraboo region these fine examples of adjusted drainage in a late mature stage and readjusted drainage in the stage of youth are exhibited side by side in striking contrast, the line of division between the two types being clearly outlined.

One of the features common in areas where readjustment of drainage is in progress is the cutting of new channels by rivers that have been partly or wholly displaced from their former courses. The Wisconsin River is a fine example of such a stream. From a few miles above Kilbourn on the north to the region of Prairie du Sac on the south, the Wisconsin flows in a postglacial channel, and in two places it has done noteworthy cutting, as stated in earlier paragraphs, but the narrow and steep-sided nature of the valley where the cutting has occurred and the extensive marshy areas along the course of the river bear witness to its youthful condition. In Skillet Creek, three miles southwest of Baraboo, there is displayed another youthful feature of the same process. In a well-adjusted drainage area falls and rapids have been obliterated and the channels of the streams have been reduced to grade. When, however, a river is for any reason displaced from its valley, it is forced to cut a new channel, and falls or rapids reappear whenever rocks of unequal hardness are crossed. At Skillet Falls the creek forms a series of fine cascades, where it cuts through layers of unequal hardness in Potsdam sandstone.