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THE LATE TERTIARY PHYSIOGRAPHIC HISTORY OF THE HIGH PLAINS OF COLORADO AND NEW MEXICO[1]

F. M. VAN TUYL[2] and J. M. COKE[3]

INTRODUCTION

The physiographic features of the Front Range of Colorado lying to the west of the Great Plains Province have been described by Lee[4] and Lovering[5].

Lee recognized two old erosion surfaces in the mountains which he designated the Flattop and Rocky Mountain peneplains. The upper and older surface which is usually referred to the Eocene occurs as remnants in the form of shoulders along the continental divide and on certain individual peaks elsewhere in the higher parts of the range. It is well developed on Flattop Mountain of Rocky Mountain National Park at an elevation of 12,300 feet.

The Rocky Mountain peneplain represents an imperfect, undulating plateau-like surface which may be observed at numerous points on the east flank of the Front Range. The existence of many monadnocks, some of which rise hundreds of feet above the erosion surface, testify to the fact that the area was uplifted before peneplaination was completed. On Lookout Mountain, west of Golden, the elevation of the surface is about 7300 feet. It rises to the westward at the rate of about 60 feet per mile. The estimates of earlier

[1]In the present paper, the term "High Plains" is applied in the broad sense to the westernmost, higher portion of the Great Plains.

[2]Professor of Geology, Colorado School of Mines, Golden, Colorado.

[3]Instructor in Descriptive Geometry and Engineering Drawing, Colorado School of Mines, Golden, Colorado.

[4]Lee, W. T., Peneplains of the Front Range and Rocky Mountain National Park, Colorado. U. S. Geol. Survey Bull. 730-A, 1922.

[5]Lovering, T. S., Geologic history of the Front Range, Colorado: Colo. Sci. Soc. Proc., Vol. 12, No. 4, pp. 59-111, 1929.

writers of the geologic age of the Rocky Mountain peneplain vary from early Tertiary to late Pliocene.

In connection with recent studies by the writers, evidence of a lower erosion surface younger than the Rocky Mountain peneplain has been found. This is developed almost entirely on the less resistant sedimentary rocks of the Great Plains and is of pre-Nussbaum age. It occurs at elevations varying from less than 6000 feet where the larger streams emerge from the mountain front to more than 6700 feet in some of the interstream areas. It is well preserved in the drainage basin of the Arkansas river in southern Colorado where it is partially buried by Nussbaum gravels. It extends from northern Pueblo County southward to the Trinidad area in Las Animas County and can be traced to the eastward for more than fifty miles from the mountain front. To the south and east of the lava-capped mesas of the Raton area in New Mexico a similar truncated surface, believed to be of the same age, appears below the dissected Ogalalla gravels. In northern Colorado the surface is more highly dissected and remnants of it have not been recognized definitely east of the relatively narrow foothills belt. The most typical remnant in this part of the state is the shoulder at an elevation of 6700 feet on the east flank of Mount Morrison, from which the surface takes its name, near the town of Morrison.

In the crystalline area of the eastern border of the Front Range the surface did not pass beyond the mature stage. It is represented here by occasional rock terraces in the valley walls.

Inasmuch as the Ogalalla gravels of New Mexico are referred definitely to the Pliocene and the field evidence is favorable to the view that the Nussbaum gravels of Colorado are of the same age, it is apparent that the physical history of the High Plains and the Front Range is more complex than formerly realized. The appearance of these gravels on an erosion surface developed by the uplift and dissection of the former eastward extension of the "Rocky Mountain" surface

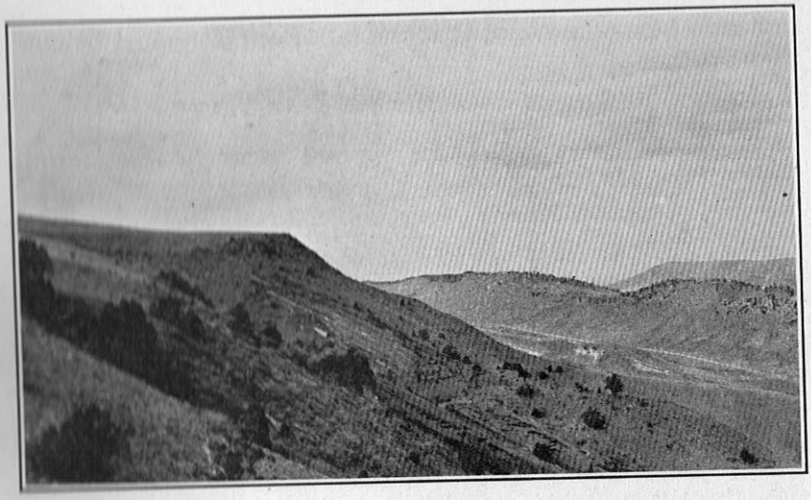

Fig. 1—View of the shoulder on Mount Morrison from a point one mile northeast. The corresponding shoulder north of the gulch is developed on crystalline rocks. (Photo by Lovering.)

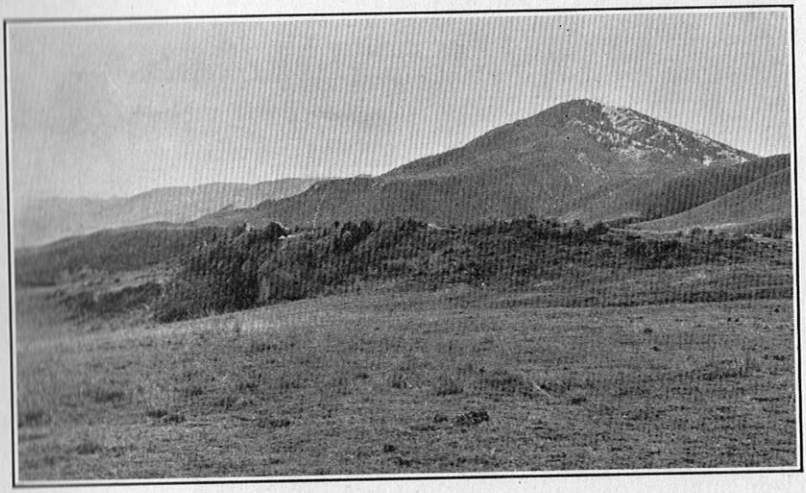

Fig. 2—View northward from the Park of the Red Rocks. Note the relation of the shoulder on Mount Morrison to the Dakota hogback, also the wind-gap in the ridge. Green Mountain in the background. (Photo by Lovering.)

Plates are transposed

indicates beyond a doubt that the latter surface must be older than Pliocene.

The Mount Morrison Surface

Several remnants of this surface occur in the foothills west of Denver, the most striking one being the shoulder on the east flank of Mount Morrison. This is developed upon steeply tilted Fountain red sandstone. It has a length from north to south of about 2100 feet, a maximum width of about 1000 feet, and an elevation of about 6700 feet. (See Fig. 1).

One mile northeast of the shoulder and at a little lower elevation there appears a wind-gap in the Dakota hogback. This is believed to have resulted from the capture of Mount Vernon Creek by a tributary of Bear Creek. It is apparent that in an earlier stage in the physiographic history of the area the tilted Dakota sandstone and other hard formations did not form hogbacks, but were worn down to essentially the same elevation as the less resistant formations on either side. Mount Vernon Creek, Bear Creek, and other eastward flowing streams then flowed across hard and soft formations alike. As a result of later uplifts and erosion the Dakota and other resistant formations were brought into relief to form hogbacks. The higher parts of the Dakota hogback in the vicinity are of almost the same elevation as the rock shoulder on Mount Morrison. (See Fig. 2). The higher portion of the present surface of North Table Mountain, a lava-capped mesa, undoubtedly represents a remnant of the Mount Morrison peneplain also. The upper portion of Green Mountain rose several hundred feet above the surface. A shoulder on the lower portion of the mountain, particularly about its south and southeast flanks at an elevation of approximately 6300 feet may represent evidence of the former presence of this erosion surface.

In the Boulder quadrangle remnants of the Mount Morrison surface appear in the higher hogbacks between Boulder and Lyons.

In the Denver area the surface has been destroyed by erosion during a later cycle.

The Mount Morrison surface is but feebly developed in the crystalline rocks along the eastern border of the Front Range because of the more resistant character of the Pre-Cambrian formations. Near the mouth of some of the larger

Fig. 3—View in Clear Creek Valley from a point one and one-half miles north of Golden. Note the well developed rock terraces in the valley walls. (Photo by Lovering.)

canyons, however, traces of the surface are preserved in the form of rock terraces. Well defined terraces of this type occur at an elevation of about 6500 feet at the mouth of Clear Creek Canyon near Golden. These can best be observed at a point about one and one-half miles north of Golden on the Coal Creek Road. (See Fig. 3).

In the northern portion of the Livermore quadrangle much broader rock terraces are developed in crystalline rock at an elevation of about 6700 feet along the north fork of Cache la Poudre river. These constitute the Alford surface of Mather[6]. This surface is unquestionably of the same age as the Mount Morrison peneplain of the High Plains.

[6]Mather, K. F., Physiographic Surfaces in the Front Range of Northern Colorado and their equivalents in the Great Plains (Abstract). Bull. Geol. Soc. America, Vol. 36, p. 134, 1925.

In the Castle Rock quadrangle of Colorado the evidence of the Mount Morrison peneplain is not so distinct. In the Perry Park area the upturned Cretaceous and older sedimentary formations have been planed down to a common level at an elevation of about 6500 feet. The broad, slightly dissected plateau of nearly horizontal Dawson and Castle Rock conglomerates and sandstones, rising to an elevation of more than 7000 feet to the eastward and southeastward of Perry Park, probably represents a somewhat higher remnant of this surface that divided the drainage basins of the South Platte and Arkansas rivers.

A peneplain which is correlated with the Mount Morrison surface appears in Pueblo and eastern Huerfano counties and in the area northeast of Trinidad in Las Animas County where the Nussbaum gravels appear to have been spread out upon the surface over a considerable area prior to its uplift and dissection. The gravels rest upon truncated formations ranging in age from the Dakota to the Fox Hills. The drawing of structure contours, using the contacts of the erosion remnants of the Nussbaum with the older formations as a datum plane, reveals the existence of such an erosion surface now partly exhumed and dissected which occurs at an elevation of from 6000 to 6500 feet along the east base of the mountains and slopes to the eastward at an average rate of about 35 feet per mile. It is lower along the valley of the Arkansas River than to the north and south. The eastward slope is ascribed in part to the initial slope of the erosion surface but very largely to renewed uplifts of the mountains after it was developed.

In eastern New Mexico gravel deposits constituting the Ogalalla formation rest upon a truncated surface which may be correlated with a considerable degree of assurance with the pre-Nussbaum surface in the Pueblo area. The elevation of this surface in New Mexico increases from 4250 near the middle of the eastern border of the state to more than 6200 feet as the mountains to the westward are approached. There is evidence that the Ogalalla formation and the underlying erosion surface were somewhat dissected prior to the out-

pouring of the lavas of the Mesa de Maya and adjacent areas. These lavas are referred by Lee to the early Quaternary. The higher lava-capped mesas of the Raton area rise a considerable distance above the pre-Ogalalla surface. The lavas of these were apparently poured out on an older, once more extensive, surface which Fenneman[7] has correlated with the Rocky Mountain peneplain. The writers are in accord with this interpretation.

Age of the Mount Morrison Surface

The age of the Mount Morrison surface cannot be determined in northern Colorado because of the lack of late Tertiary deposits in relation to it. However, a similar peneplain in the Arkansas basin which is correlated with the Mount Morrison was buried with Nussbaum gravels. Unfortunately the lack of definite information regarding the age of these gravels makes it imposible to fix definitely the age of the erosion surface. Estimates of their age range all the way from Miocene to early Pleistocene. They are referred to the Pliocene by the U. S. Geological Survey. The Ogallala gravels that were laid down on a peneplain in eastern New Mexico, believed to be of the same age as the pre-Nussbaum surface, are definitely Pliocene. It is probable therefore that the Mount Morrison surface was developed as early as late Miocene time and that the Rocky Mountain peneplain cannot be younger than early or middle Miocene. There is evidence that several later episodes have been involved in the development of the present surface of the High Plains.

The writers are indebted to T. S. Lovering for helpful suggestions during the preparation of this paper.

[7]Fenneman, N. M., "Physiography of Western United States," McGraw-Hill Book Co., p. 45, 1931.