GLACIAL AND INTERGLACIAL DEVELOPMENT OF CHITTENANGO FALLS STATE PARK IN CENTRAL NEW YORK

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INTRODUCTION.

Drift-filled interglacial gorges have long been known from various localities in the southern Finger Lakes region of New York State, and ably interpreted by Tarr, Von Engeln, Rich and Filmer, and others. Similar evidence of interglacial erosion was noted at Chittenango Falls State Park in 1931 by the writer in company with Dr. Earl T. Apfel of the Geology staff at Syracuse University. Professor Apfel has kindly advised in the study of the area, and courteously assisted in the preparation of this paper.

DESCRIPTION AND INTERPRETATION.

Chittenango Creek drains nearly seventy-five square miles of territory at the northern margin of the Allegheny Plateau in central New York (Fig. 1). The last ten miles of its descent from the plateau lead through a narrow and picturesque valley. About midway in this valley the stream falls in a precipitous cascade over a series of massive limestone strata. It is a waterfall of exceptional beauty, 134 feet in height. A conspicuous ledge about halfway down breaks the continuity of the cascade, perhaps adding a bit to its attractiveness. This waterfall, known as Chittenango Falls, and its environs now constitutes one of the New York State Parks, and claims an increasing number of visitors each year.

Downstream from the waterfall, the limestone forms a moderately narrow gorge for about a quarter of a mile. Beyond this point the rock gorge is much wider and the cliff on the west side is concealed for a considerable distance by glacial drift which partly fills the valley. In a few places on the east side the stream is now cutting against shales which underlie the limestones; at other places the stream course is over an unknown thickness of drift filling beneath the valley floor. In many places, back from the floodplain, the limestone forms vertical cliffs of varying heights. A well developed moraine constricts the valley about three miles below the waterfall, and another moraine extends across the valley a

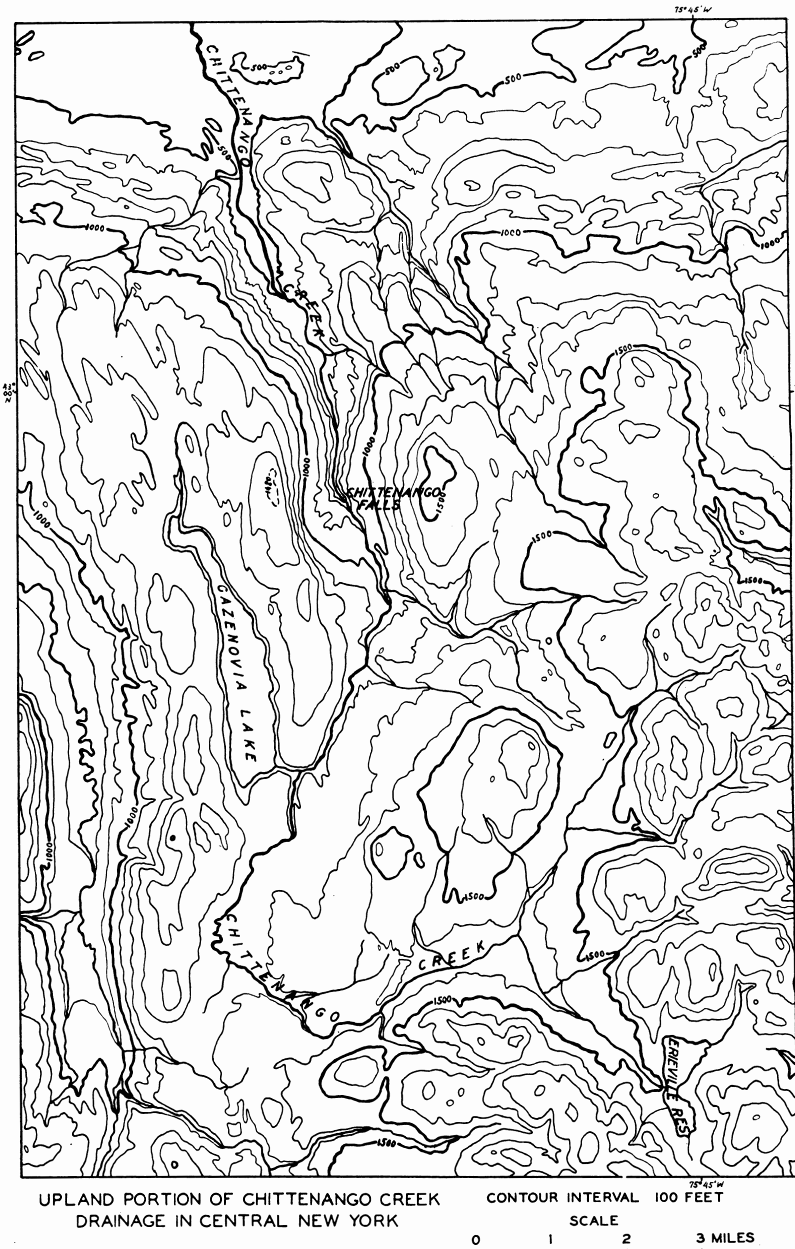
75°45' W
CHITTENANGO
CREEK
CHITTENANGO FALLS
CAZENOVIA LAKE
CHITTENANGO
CREEK
ERIEVILLE RES
43° 00' N
500
1000
1500
UPLAND PORTION OF CHITTENANGO CREEK
DRAINAGE IN CENTRAL NEW YORK
CONTOUR INTERVAL 100 FEET
SCALE
0 1 2 3 MILES

FIG. 1.

mile or more above the waterfall. These moraines are readily distinguishable on the U. S. G. S. topographic maps of the Chittenango and Cazenovia quadrangles, respectively.

Difference in erosional resistance offered by the several rock formations into which this valley is cut has provided the setting in which the interglacial evidence at this park has been preserved. The controlling topographic element is a series of massive limestone beds, about 175 feet in thickness. It includes the Manlius and Helderberg groups of this region, and a large part of the Onondaga formation. The gentle southward dip of the strata and the north-sloping stream gradient combine to bring the base of the limestone series to the bottom of the gorge in the vicinity of the park. Above the massive Onondaga beds, the character of the rock changes abruptly to the fissile black shales of the lower part of the Hamilton group.[1] Removal of these overlying shales by erosion has left a wide limestone terrace on the east side of the valley. This stripping may have been accomplished by glacial action or by normal subaërial erosion; or more probably it is the combined result of both. At any rate, stream diversion across this terrace in Pleistocene time led to the development of the interglacial gorge diagrammed in Fig. 2.

At least three stages of gorge development are displayed in the Chittenango Falls park. What appears to be the oldest one is buried under drift near the west side of the valley (Fig. 2, A-B). The rock gorge widens abruptly at this point, the limestone wall on the west side being completely hidden under the drift which forms the west side of the present gorge for some distance below. The outer margin of the rock terrace on the east side reveals a part of the moderate slope which led down into this ancient valley (Fig. 2, E-H). The lowest exposure of bedrock on this slope occurs in the bed of the small stream entering the present gorge at this point, and shows a decline of about forty feet below the rock terrace level fifty yards away. Except for this instance, no rock outcrops occur along this stream, though its bed is lower than the limestone terrace for a quarter of a mile upstream. The first road constructed through the valley utilized this break in the gorge wall to effect a passable grade from the lower to the higher level. The land surface above this buried gorge is quite rugged in places, due in part to erosion by tributaries of the small stream to which reference has already been made,

[1]Cooper, G. A., this Journal, 5th. ser., vol. **19**, pp. 116-134, 214-236, 1930.

and in part to depositional irregularities or to slumping following the melting of buried ice masses. The position of the upper end of this oldest gorge is not known, but it is probably at least a few hundred yards upstream from this point. Also its width is unknown because of the heavy drift cover. It may be inferred from the character of the upper part of its slope that it had been widened considerably and was therefore less steep-sided than the later rock gorges.

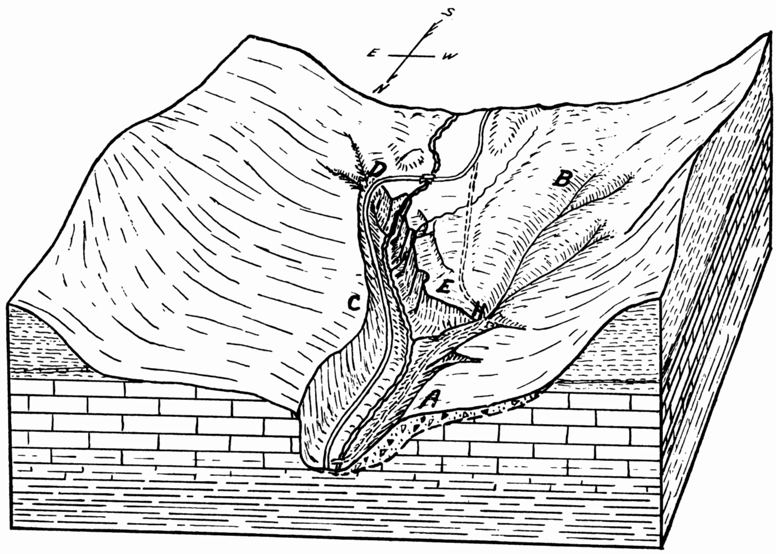

Fig. 2. Block diagram showing relative positions of the several gorges at Chittenango Falls State Park. Oldest gorge, A-B, drift-filled. Interglacial gorge, CE-D. Present highway shown in solid lines, abandoned highway in dashed lines.

The age of this earliest gorge may be glacial, preglacial, or interglacial; though the evidence seems to favor interglacial. Two prominent hills with over-steepened sides rise above the valley on either side of the park in such a manner as to indicate that a preglacial col existed between them. It is a situation of frequent occurrence in the adjacent Finger Lakes region, and excellently interpreted by Monnett.[2] If such were the case, the col may have been obliterated by glacial erosion, and a valley developed by the same means in

[2] Monnett, V. E.: this Journal, 5th ser., vol. **8**, pp. 33-53, 1924.

the limestone between these hills. From a study of other comparable instances in which the circumstances for such glacial erosion seem equally favorable, and in which the underlying limestone was but slightly eroded, it seems more probable that the erosion of the limestone in this earliest gorge was accomplished by stream wear after glaciation had cut down the col to the limestone horizon and had shifted the divide farther south so as to increase the size of the drainage area. However, the varied direction of stream flow within this drainage basin as it is at present is doubtless the result of a complex history, in which preglacial or interglacial stream piracy may have had a part (see Fig. 1). For this reason, it seems best to regard an interglacial age for the oldest gorge at Chittenango Falls as only a tentative conclusion. Subsequent to its formation, it became completely filled with glacial drift.

Following the disappearance of the glacier, whose deposits buried this first gorge, the interglacial Chittenango Creek flowed for a distance along the limestone terrace on the east side of its former channel, entering the latter at the location C-E, Fig. 2. In the ensuing interglacial time it eroded the gorge extending from this point southeastward for a little more than a quarter of a mile. The rock walls on either side of this second gorge show its nearly uniform width and steep-sided form. It narrows at the upper end (shown at D in Fig. 2) where two small ravines expose the approximate upstream limit. It is evident that the crest of the waterfall had receded faster than the base, resulting in a cascade much less steep than the present one. The size of this gorge, and its slight downstream widening, indicate that the interglacial stream must have been of about the same size as that of the present. At least it was no larger.

Subsequently, the region was again glaciated and this second gorge was filled with drift. Striae on the terrace indicate that ice movement was parallel to the major axis of the valley (nearly due N-S), and huge blocks of limestone were pushed into the gorge from the northeast side and incorporated into the till. The postglacial stream has only partially removed this bouldery till, so that the State Highway utilizes it in ascending to the terrace level. It is especially significant that the upper end of this gorge still retains its drift filling, since it shows the extent and character of interglacial stream activity.

In early postglacial time, the stream apparently flowed for a time over the rock surface on the southeast side of the interglacial gorge, sweeping away any drift which may have been there and producing a decidedly waterworn appearance on the ledges and low benches found on this side of the gorge. A semicircular notch indenting the southwest side near the lower end (near E, Fig. 2) marks a former position of the postglacial waterfall. No stream occupies it at present. Another notch, somewhat larger, occurs nearer the present site of the waterfall, where a small brook enters. This also seems to have been occupied by the main stream for a brief interval before it finally became established at its present location, in which the stream approaches the interglacial gorge at nearly right angles. This adjustment was evidently accomplished in a relatively brief time, and the third stage of gorge cutting was inaugurated. The length of this recent gorge is not more than 200 feet, and serves as a measure of postglacial time in this region.

The second gorge,—the only one here interpreted definitely as interglacial,—is about 8½ times the length of the postglacial gorge. Assuming a value of 20,000 years for postglacial time, and a similar rate of lengthening for each gorge, the interglacial time represented here would be 170,000 years. Although there is no definite proof that this time span was continuous, such an assumption is not at all unreasonable. Also, there is the possibility that the gorges interpreted as the first and second may be reversed in their order of age, though this is unlikely. But the fact of interglacial erosion is well established.

Regarding the rate of postglacial waterfall recession, it is probable that the first few tens of feet were accomplished at a rate more rapid than that of the present. At the start, the fall was apparently over a vertical cliff. The brink was, therefore, less supported, and hence more quickly eroded, than is now the case, where underlying strata project successively beyond those overlying. If this is true, the length of interglacial time may have been greater than that postulated, perhaps a total of 200,000 years. The tendency of the present waterfall seems to be toward a less abrupt form of cascade, due to more rapid recession at the brink than at the base. It will, therefore, approach the form of its interglacial predecessor.

SUMMARY.

Interglacial erosion at Chittenango Falls State Park in central New York is represented by a gorge about a quarter of a mile in length, cut in thickbedded limestone which forms a broad valley terrace. Its dimensions indicate a volume of water comparable to that of the present stream. Postglacial erosion has resulted in a similar gorge only 200 feet in length, branching from the interglacial gorge near its head. If the rate of interglacial erosion was the same as that of the present, the time required to develop the interglacial gorge would be 8½ times the length of postglacial time. Assuming the latter to be 20,000 years, an interglacial time of at least 170,000 years is indicated.

Topographic evidence from the upland immediately adjacent indicates that the channel along whose side the limestone terrace exists may also be interglacial in age, probably earlier than the one on the terrace. But the evidence seems not to be conclusive, and only a tentative interpretation is made.

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