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GLACIAL MARKINGS IN SOUTHEASTERN IOWA

BY FRANCIS M. FULTZ.

In the third annual report of the Iowa Geological Survey Dr. C. R. Keyes has treated, at considerable length, of the glacial scorings in Iowa. Among others, several localities were given from Des Moines county, of which two were described somewhat in detail by the present writer. Since the above mentioned article was prepared a somewhat more extended and minute search has been made, with the result that several other localities showing glacial scratches have been discovered. Also, some attention has been given to a study of the phenomena accompanying these markings, with a view of determining the general direction and sequence of the ice streams. It is scarcely to be doubted, from the great variation in the direction of striæ, that the ice flow from time to time changed its course. While all markings show a northwest and southeast trend, some of them are very nearly north and south, others very nearly east and west. Again, it is commonly accepted that these scratches were necessarily made by the ice moving from somewhere in the north and west; but there is good evidence to show that this territory was once invaded by the ice from the Huron district moving through Illinois.

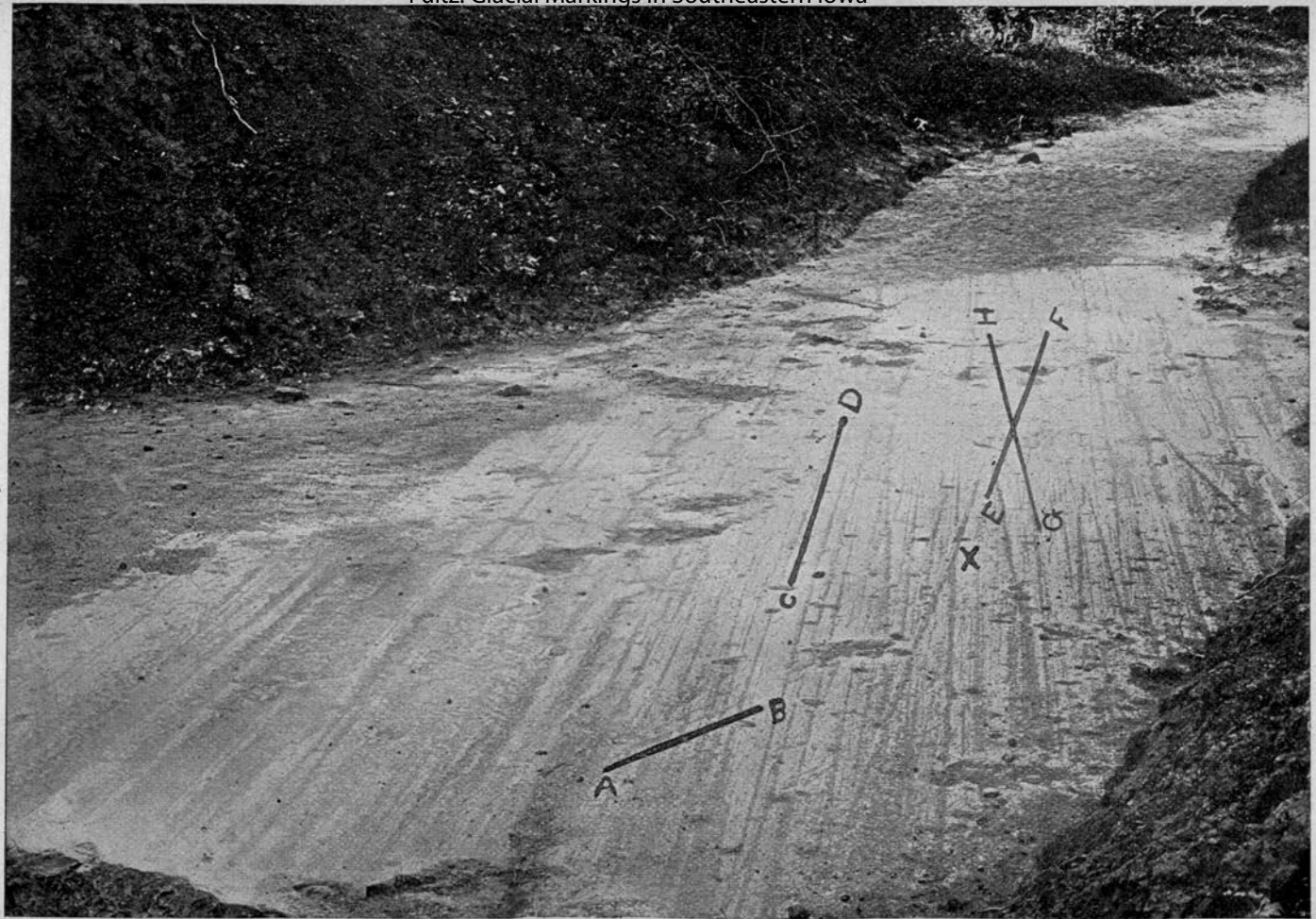
First, let the localities heretofore known and described from this section be briefly mentioned. From the vicinity of Burlington: by White, S. 15° E.; by Keyes, S. 63° E.; by Leverett, S. 65° E.; also by the present writer at points near West Burlington and at Kingston. As already mentioned, the last two exposures mentioned have been fully described elsewhere. The one at Kingston is at the very top of the bold bluff which borders the flood plain of the Mississippi. It was brought to light by the changing of a small water course, and exposes a glaciated surface 100 feet in length and 25 feet in width. It shows the top platform of rocks to have been planed off perfectly level.

On account of the recent breaking away of rock, this level floor extends out to the perpendicular face of the escarpment. The floor is crowded with striations and grooves, all finely preserved. Four different sets of scratches may easily be determined, each consisting of perfectly straight, parallel grooves. Some of these grooves in the latest series are fully an inch deep, while those from the earlier are nearly obliterated. The trends, given in the order of apparent age, are as follows:

1. South $30^{\circ} 15'$ east. *A-B*, Plate xxi.
2. South 64° east. *C-D*, Plate xxi.
3. South $60^{\circ} 30'$ east. *E-F*, Plate xxi.
4. South $72^{\circ} 15'$ east. *G-H*, Plate xxi.

These angles were taken with surveyor's compass and corrected 7° for deviation.

The oldest series is nearly obliterated by the planing of the later ice movements but its traces are very numerous, and it undoubtedly records a long unwavering movement of the ice stream in one direction. The second set shows the most prominently on account of the greater number of deep grooves, on which the later cross movements have made but little impression. The scratches of the third and fourth sets are not very numerous, but some of them are quite conspicuous. By a study of this glaciated surface, something may be learned concerning the relative time and continuance of the different ice movements in this locality. The rock floor is the hard, compact limestone of the Upper Burlington, which, since the passing of the ice sheet, has been covered by typical undisturbed drift. The markings of the two later movements are of like prominence; and which is the earlier is only determined by a study of the intersection of two of the grooves. This would indicate either, that the grooves formed very rapidly, or else that the planing of the rock floor was exceedingly slow. The grooves of the two later are not of much greater depth than those of the second; but the number of grooves in the second set is more than double those of the third and fourth combined. The oldest set of all was almost planed away by the ice stream of which the second set is the record. This clearly indicates that time was an important factor in deciding the number of grooves. In all probability the actual periods represented by the third and fourth sets were of considerable duration; but each was comparatively short in comparison with the second. It is easy to see how these grooves could be cut to a considerable depth



before many of them were formed or much of the surface worn away.

It might be taken for granted that the ice movement was from northwest to southeast as is universally conceded; but, as already stated, there is but little doubt that the Illinois ice sheet once held possession, and it is barely possible that those striæ which are more nearly east and west might be its product. However improbable it is, while the possibility remains, the question is open for argument. The accompanying phenomena here all indicate movement to the southeast. The depressions in the rock floor, caused by fossils or concretions, are more abrupt on the northwest side than on the southeast, and when a groove cuts through one of them it perceptibly widens on the southeast. But more conclusive evidence than this is where one groove intersects another. The angle to the northwest is sharp, clear-cut and distinct, while that to the southeast is blunted and rounded off, exactly the effect that would be expected with movement from the northwest. Fragments entering the intersection would be somewhat freed and would strike against the projecting angle, thus breaking it away. It seems conclusive that all movement indicated by these striæ, including that which is most nearly east and west, was from the northwest toward the southeast.

The trend of the bluff at this place is from north to south about 5° west. It will be seen that the latest scratches are nearly at right angles to the escarpment, while the earlier ones cut it at a comparatively sharp angle. The inference might be that the earlier ice flow was entirely independent of, while the later one was influenced by, the local topography. The Mississippi exerted little or no influence on the earlier flow, but near the close of the ice age it maintained a wide, open channel directly into which the ice stream pushed. If this were true, then we ought to find the valley full of erratics and terminal débris. There is great probability that the boulders lie thickly strewn beneath the surface of the old flood plain; but they lie deeply, for the valley has been silted up many feet. There is one place, however, where, in time of extreme low water, these erratics may be seen in great numbers in the present channel of the river; also, along the line of the bluff itself there is abundant evidence.

The other locality described in the article before referred to, is near West Burlington. This exposure is illustrated in figure

2, and also in plate xxii. This came to light by stripping in the Loftus quarry. The striated surface thus exposed was large, and was especially interesting because it showed both floor and lateral erosion; and also because the surface rose in benches. The markings of the floor surfaces were the same as that described from Kingston—continuous, parallel, straight grooves. But the lateral scoring, which showed on the rise from one bench to another, consisted of a multitude of fine

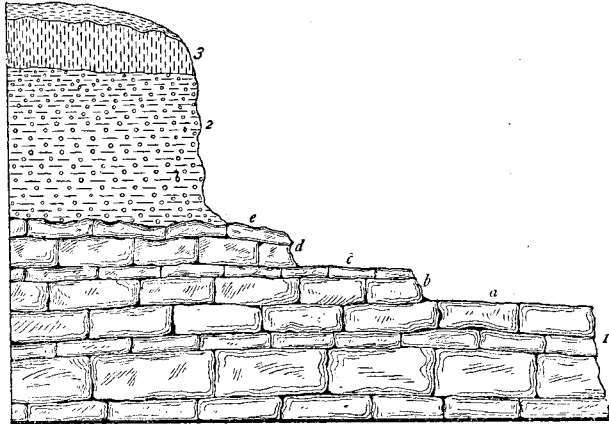


Figure 2. Section at Loftus quarry.

scratches, which were not parallel, but crossed one another at small angles. Where the angle of the bench had become much worn away it exhibited a tendency to grooving. The lateral surface also showed gouging where the rock was softer, while the floor surface did not. The direction of the striæ was south 75° east, which is also the trend of the bluff, which here borders the valley of a small stream. There was only one series of striæ, so the test of intersecting grooves cannot be applied to show in which direction the ice stream was moving. The lateral erosion indicates that the movement was towards the southeast; for, wherever a projection occurs, the shoulder toward the northwest is cut away to a much greater degree than the one to the southeast.

Recently three other areas of glacial scoring have been located. Two of these are in the vicinity of Starrs Cave, four miles northwest of Burlington. They are at the very summit of a projecting mural escarpment, 100 feet above the bed of Flint creek. They are not more than forty rods apart, yet one shows a direction of south 33° east and the other south 73° east. These



LATERAL ICE EROSION AT LOFTUS QUARRY.

angles were taken with a compass and corrected 7° for deviation. The trend of the bluff is in a curve, which, together with the difference in angle, brings the first mentioned scratches parallel, and the latter at right angles to the escarpment. The two surfaces are on about the same level. They are somewhat weather-worn, so that all the fine striations are gone; but the larger grooves show very distinctly. The locality is about two miles from the bluff bordering the Mississippi flood plain.

The other place is about half a mile distant from the one previously described from near Kingston. To distinguish between them, they have been designated as Kingston No. 1 and Kingston No. 2. This later discovery is on the brow of the bluff, and extends from the top some distance down the face. The bluff is rounded off, and descends at an angle of about 30° . It has no covering of loess, or drift and is but scantily concealed by occasional patches of soil. The scorings range over a considerable area, not continuously, but in numerous places. No fine striations show, for the rock is much weather-worn; but the larger grooves are very plain and distinct. These appear at intervals from the summit of the bluff some distance down the face. The direction was not taken with a compass, but is approximately south 70° to 75° east, which corresponds to the latest series of Kingston No. 1. The scorings at this place would seem to bring additional evidence that the ice movement was eastward. The bluff faces east and rises at an angle of about 30° ; and while it is conceded that a glacier may move up a moderate incline, yet it is doubtful if there would be motion on the under surface, where the rise is as much as above given.

As already stated, there have been several well-authenticated discoveries of glacial scorings within the city of Burlington. The finds have always been on the verge of the escarpment crowning the North Hill bluff. Exposures at this place are not likely to remain any length of time, for, either the loess slides down and covers them, or else a portion of the ledge breaks away. Recently a very careful investigation of the bluff was made from the north end of the city to a distance three miles below, and the only piece of rock scoring found was on a detached block which had been previously pointed out by Mr. Frank Leverett, who reported that he had seen it in place not more than three or four years ago.