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Glaciated Surfaces in Central Iowa

By CHARLES S. GWYNNE

Introduction. Glaciated bedrock surfaces are of course known from many parts of the world. Many have been described. Some have been examined in detail for what they might disclose as to the behaviour of glacial ice and the process of glacial erosion. Many undoubtedly are or have been exposed in Iowa and other parts of the midwest within recent times, but few have been reported in the literature, at least from Iowa. Only ten localities having striae are shown, in Iowa, on the Glacial map of North America (Flint, 1945), whereas there are relatively many more shown in states to the east. Most of those for Iowa are in the southeastern part of the state (Fig. 1), quite distant from the occurrences to be described in this paper. Those shown on the glacial map are from various sources, possibly brought together in a paper by Norton (1911), although a few reported by Norton do not appear.



Fig. 1 - Glacial striations in Iowa, from the Glacial map of North America, with additions: Ames (1); LeGrand (2); and Winterset (3).

It would seem reasonable and desirable that the location and description of such surfaces should be made a part of the record, and possible interpretations made. The surfaces may not always be available. Those disclosed in quarrying operations can easily be destroyed or covered up.

It is the writer's purpose to describe and comment upon three significant occurrences in the central part of the state which have come to his attention. These are at quarries (1) north of Ames, Story County; (2) north of Le Grand, Marshall County; (3) east of Winterset, Madison County (Fig. 1). No striae are shown at these localities on the Glacial map of North America, and for one of the localities, that of Winterset, there is no record in the literature.

Quarries north of Ames. Beyer (1898, p. 184) in his report on the geology of Story County described a glaciated surface beneath a pre-Mankato drift on the Mississippian limestone north of Ames in the SW $\frac{1}{4}$ sec. 25, T. 84 N., R. 24 W. (Franklin Tp.), and gave the bearing of the striae as S. 38° E. The surface herein reported for the first time lies about two miles north of that recorded by Beyer, in the NE $\frac{1}{4}$ sec. 23, and the NW $\frac{1}{4}$ sec. 24, T. 84 N., R. 24 W. (Franklin Tp.). It was uncovered in the course



Fig. 2. Glaciated surface at Ames; view northward. Till face at right.

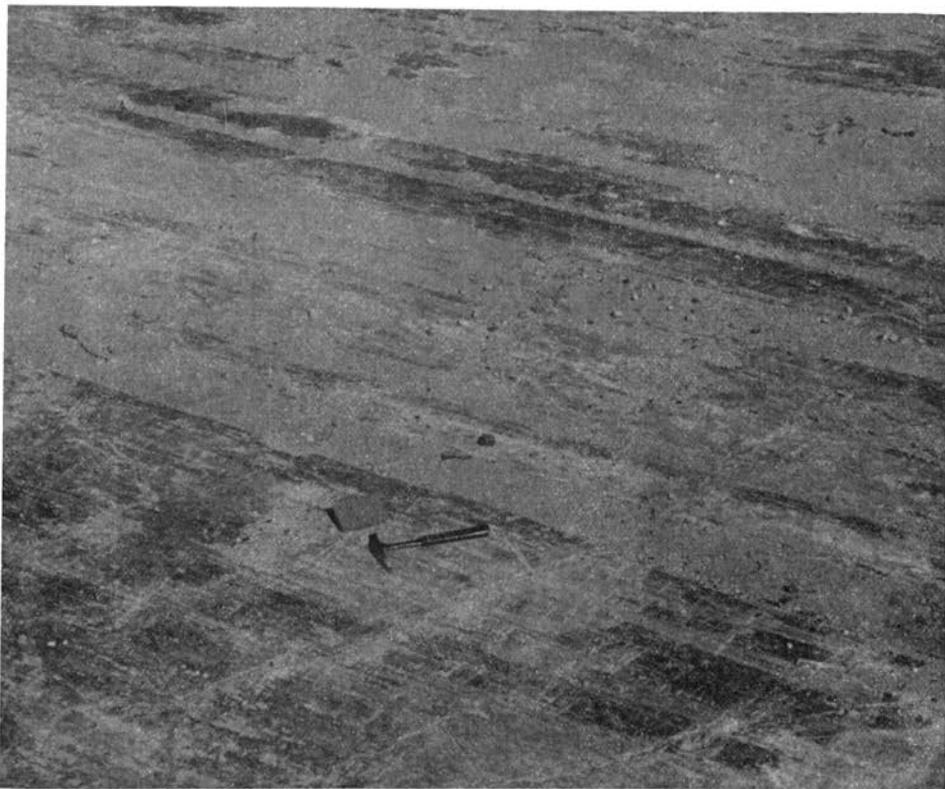


Fig. 3. Detail of glaciated surface at Ames.

of the operations at two large quarries, which were opened about 1940.

The new quarries lie on the south side of the Skunk River valley, with the limestone rising rather abruptly along the valley side and the river flowing at the base of the slope. The glaciated surface under consideration was exposed in the west quarry. The northern part of the stripped surface, for a distance of a few rods from the edge of the bluff, was not planated. Reasonably, so close to the valley side where the mantle was thin, a planated surface, if it existed, might have been destroyed by weathering. The operations from about 1942 on laid bare at one time an estimated area of two thousand square yards of an exceptionally well glaciated surface (Figs. 2 and 3) overlain in part directly by unleached Mankato till and in part by an older oxidized till. This glaciated surface has since been destroyed in quarry operation. The glaciated surface sloped southward on a bed of fine-grained limestone. Mankato was

directly on top of the bedrock at the north, but toward the south a thin deposit of the older till, increasing to thickness of a few feet, separated the Mankato from the bedrock. Still farther south a poorly indurated bed of sandstone, increasing in thickness southward, lay above the limestone and beneath the older till. The drift reached a maximum thickness of about 40 feet on the glaciated surface.

The glaciated surface was present only on the limestone. The rock surface was smoothed and generally striated with scratches up to several feet in length and one-half inch or more in depth. There were few departures, and those generally of only a few degrees, from the prevailing trend of approximately S. 45° E. for the striae beneath the Mankato till. Beneath the older till the striae trended approximately S. 34° E., close to the bearing of S. 38° E. recorded by Beyer for a locality a few miles south.

The presently accessible bedrock surface of the second quarry, a few hundred yards east of the foregoing, has only a few square yards of glaciated surface, with striae bearing S. 27° E. The bedrock elevation is approximately the same as at the west quarry, but stratified drift lies immediately above the bedrock.

2. Le Grand Quarries. There have been quarry operations in the vicinity of Le Grand and Quarry, Marshall County, since about 1860 (Beyer, 1896, p. 242). By far the largest development in the area, now known locally as the south quarry, has taken place in the SW $\frac{1}{4}$ sec. 1, T. 83 N., R. 17 W. (Le Grand Tp.), on the south side of the Iowa River valley. Another large quarry lies to the north on the opposite side of the river in the NW $\frac{1}{4}$ of the same section. The quarry face of the south quarry has a length of over one-quarter of a mile, and glacial markings have been found on the bedrock surface through this distance. This quarry face has only one interruption, a rock-walled ravine approximately a rod each in width and depth at the face. The age of this cannot be determined.

Glaciated surfaces on the Mississippian limestone in the vicinity of Le Grand and Quarry were described by Beyer (1896, p. 239-240), and Norton (1911, p. 79-83), but no striae are recorded for this locality on the Glacial map of North America. The striae recorded by Beyer trended S. 20° — 25° E. These are believed to have been from the vicinity of the present south quarry. In addition Norton found striae bearing S. 47° E. and S. 35° — 64° W. These are thought to have been from localities north of the river. The surface dealt with in this paper is one which was not available to Beyer and Norton.

The face of the south quarry is now a few hundred yards east of the place of first operations, so that the glaciated surface is well back from what was the valley side. Mantle has a maximum thickness of about 60 feet, including about 40 feet of drift, possibly of two ages, and 20 feet of loess. It extends to the edge of the face in most places and observations are not easily made. A few years ago, however, an area of about three thousand square yards, almost directly east of the crusher-plant, was cleared of overburden so that the glaciated surface became available for examination. It is overlain directly by unweathered till.

The face trends S. 17° E. The surface marked by the glacial ice is on two levels, each approximately horizontal, the lower to the north. From the north the bedrock surface rises gently about six feet to the higher level along a stoss surface which extends approximately S. 42° E. Both areas are generally smoothed and bear striae up to a rod in length and to about as much as one-half inch in depth. Striae of the northern area vary little from the prevailing trend of S. 32° E. West of the ridge and on the higher level the striae average about S. 25° E.

Scattered observations north of this large cleared area show a change in the bearing of the striae, from S. 35° E. at the south, to S. 47° E. at the north. There is thus recorded along this quarter-mile face a change in bearing of approximately 22°, from S. 47° E. at the north to S. 25° E. at the south.

So far as known the bedrock surface of the north quarry has disclosed no evidence of glacial planation. None can be seen at the present time.

3. Quarries east of Winterset. A glaciated surface was first noted in this area by the writer in 1938, on the Pennsylvanian limestone of the Pennsylvania Dixie Cement Corporation quarry about two miles east of Winterset on the north side of Middle River valley in the NE $\frac{1}{4}$ sec. 33, T. 76 N., R. 27 W. (Union Tp.). The area, several thousand square yards in extent, has since been destroyed in the course of quarry operations.

At the present time (April 1950) an exceptionally fine glaciated surface estimated to extend over a few thousand square yards, is exposed in the north workings of the Sargent Brothers Company quarry on the south side of Cedar Creek valley in the SW $\frac{1}{4}$ sec. 27, T. 76 N., R. 27 W. (Union Tp.). Striae trend S. 22° E. The surface is generally a planned one, quite level and smooth, with many scratches up to several yards in length and as much as an inch in depth.

At the present time also a stripped area almost a half mile in length and up to a few hundred yards in width at the cement company quarry, less than a mile south of the Sargent quarry, shows no evidence of glacial planation. This is on the north side of the valley of Middle River. It is notable that here much soft and weathered rock has been removed in the stripping operation. The overburden of drift and loess in the two places is estimated to average no more than approximately 30 feet. This surface is uninterrupted by erosion channels.

Discussion. Glaciated surfaces in Iowa have been described in papers by Keyes (1895), Fultz (1895, 1896), Fitzpatrick (1898), and Norton (1911). The reports by Beyer on Marshall (1896) and Story Counties (1898) deal with them briefly, and it is possible that they are noted in other county reports. However, the papers on the Pleistocene of Iowa by Kay and Apfel (1929) and by Kay and Graham (1943) make no mention of glaciated surfaces, which might be interpreted as their being viewed as of little significance or as insufficiently known. As noted, the Glacial map of North America (Flint, 1945) shows ten localities having striae in Iowa. More certainly were known at the time of publication, and it is recognized that no claim was made for completeness in this regard. However, the occurrences which have been described in this paper are many miles from any shown, and add significantly to the record.

The question arises, are glaciated surfaces in Iowa more or less abundant than has been believed? At first thought it would seem to the writer that they are less abundant than might be expected. The impression that they are not abundant is based upon the examination of cleared surfaces connected with quarry operations, mostly in the central part of the state. These are almost always upon limestone and the limestone surfaces of many quarries show no glacial planation. The feeling that they should be more abundant than they are is based upon three facts: first, that ice-sheets extended well beyond Iowa and that some parts of the state were covered four times or more; second, the widespread limestone bedrock is favorable for the taking of glacial markings; third, an impervious till covering, as others have pointed out, would preserve the planated surface.

Kay and Apfel (1929, p. 29), in commenting upon the erosion by glaciers in Iowa, made the following statement:

Suffice it to state here that (a) the abundance of foreign material in the drift of Iowa, (b) the extent of undisturbed surfaces of older drifts which have been over-ridden by glaciers, (c) the absence of deep

grooves and striae on rock surfaces, (d) the persistence of abrupt rock-walled gorges in areas which were glaciated, (e) the fact that the ice sheets advanced over areas which had long been subjected to weathering, and hence covered with much material available for transportation, suggest strongly that the ice sheets were well loaded when they invaded Iowa, and although their planing action in places may have been great the relative reduction of the relief of the surfaces probably was inappreciable.

Of course this statement applies only to the reduction of relief. Nevertheless the existence of the extensive planated surfaces described from these three localities, together with the absence of pre-glacial ravines in some of the large cleared surfaces of limestone, as at Le Grand and Winterset, is evidence on the side of more planation than is suggested by the conclusion of Kay and Apfel. Yet as stated glaciated surfaces are none too abundant.

In this connection it may be well to recognize that quarries are almost always opened up along the sides of valleys, where mantle is thin, and where weathering related to ground water circulation would be likely to destroy the planned surface for some distance back from the outcrop. Hence the glaciated surface might not show up until thicker overburden was reached. Such appears to have been the case at the Ames quarry. The extensive surface at Le Grand, almost lacking in erosion channels, suggests great planation. This surface is as noted well back from the original valley side. Beyer long ago noted glacial planing in this vicinity, at a lower level, apparently nearer the valley side, but this was after the quarries had been some time in development. It would appear to the writer likely that as quarries are extended farther away from the outcrop more glaciated surfaces will appear. Obviously, with the extension of quarry operations such as has occurred over the past few decades, more and more glaciated surfaces should be uncovered.

The three surfaces which have been described are in a sense on stoss slopes since they are on the sides of valleys against which the ice moved. This may have contributed to their extensive development. The unglaciated surface of the Pennsylvania Dixie Cement Corporation quarry is essentially on a lee slope.

It is recognized that striae record only the direction of movement of the ice at one time. The direction may have been different both before and after the striae were made. Nevertheless numerous and widespread observations should be significant. The bearing of the striae of the three localities described in this paper shows definite ice movement toward the south-southeast and southeast. From the bearings at Ames it is evident that the movement of the Mankato

ice which made some of the striae was more toward the southeast than that of the ice sheet which left the marks beneath the older till. The bearing of the younger striae at Ames is about what might be expected from the outlines of the Mankato and the trend of the minor moraines (Gwynne, 1942), in that area.

The recordings along the length of the exposures at Le Grand are believed to show the influence of topography upon the direction of ice flow. At the north striae bear S. 47° E. At the south they are S. 25° E. The ice here, coming from a northwesterly direction, impinged against a rock-walled valley side, trending northeastwardly, and the plastic ice was diverted more toward the south. The minor obstruction presented by the small stoss surface crossing the large cleared area had no effect upon the direction of flow.

Conclusions. Three areas of ice planation have been described. The bearings of their striae are recorded. The areas are sufficiently extensive to give significance to these bearings. This forms a contribution to our knowledge of the ice movement in the central part of the state.

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