EARLY WISCONSIN GLACIATION IN THE MIDDLE WEST

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Abstract

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Preface

In recent years, several changes have been proposed in the classification of the Wisconsin Stage of the Pleistocene Epoch. For the early Wisconsin of the Middle West, such classification terms as "Altonian" (Frye and Willman, 1960), "Rockian" (Black, 1961), and the more general term "pre-classical Wisconsin" have appeared in the literature.

The purpose of this paper is to review the original evidence under which the early Wisconsin substages of Farmdale and Iowan were established, to present more recent evidence favoring their retention, and, in the light of this evidence, to critically examine the problem of "pre-classical Wisconsin" glaciation.

The Farmdale drift

Drift which the writers consider Farmdale in age occupies the Pecatonica lobe in northern Illinois and the Eau Claire area of west central Wisconsin, emerging from younger Wisconsin drift to east and north (see fig.). The Pecatonica lobe is a relatively small area east, north, and west of Rockford, paralleling and including Pecatonica River Valley as far west as Freeport beyond which lies the Illinoian drift to the Driftless Area (Fig.). This drift also extends into Wisconsin where it lies west of the Johnstown moraine and east of the Illinoian drift area. This latter tract has received ~~only~~ comparing reconnaissance study.

Discovery of the Farmdale drift

The intriguing story of the discovery of the Farmdale drift began to unfold with the recognition of a thin pinkish-brown, non-calcareous loess beneath Iowan loess in an auger boring made by the present senior author in northwestern Illinois in 1920*. Further work showed that this loess, with a humus layer at the top, had a definite stratigraphic position between weathered Illinoian drift below and the Iowan loess above, over large areas of northwestern Illinois (Leighton, 1923) and in the famous Farm Creek section (Idem, 1925, 1926, 1931), east of Peoria. Leighton called it "Late Sangamon loess."

In the years since 1920, this loess has come to be widely recognized, over western, central, and northeastern Illinois, including a considerable area where it and the Iowan loess occurs beneath drift of Tazewell age, in eastern and western Iowa, in Missouri, southern Illinois, southern Indiana, and in adjacent parts of Kentucky along Ohio River and down the Lower Mississippi. Although thinner than the younger loess above, it bears similar genetic relationships to the Illinois and

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*Field note no. 4, Stephenson County, July 13, 1920.

Mississippi rivers in Illinois (Smith, 1942), to the Ohio (Ray, 1959), to the lower Mississippi (Wascher et al., 1947; Leighton and Willman, 1950), and to the Missouri (Ruhe, 1954; Daniels and Handy, 1959).

With a better understanding of soil profiles that came ~~since the 20's~~ during the 30's, the soil profile on this loess was appraised as an A/C profile, representing a relatively brief time. The loess also was found to have a genetic relationship to major valleys which led Leighton (1947) to propose that the name "late Sangamon loess" be changed to Farmdale* loess, and to infer that the Farmdale loess recorded a pro-Wisconsin valley train. In 1953 he raised the question, "Is there a Farmdale drift in northern Illinois west of the Shelbyville moraine?" (Leighton, 1953, p. 8).

Recalling that in the early 20's he had reluctantly classified as Illinoian a rather youthful drift in northern Boone and Winnebago counties which lay beyond the known Wisconsin drift margin, Leighton arranged with Paul R. Shaffer of the University of Illinois to make the study.

The following year, Shaffer (1954) published a statement, in part as follows:

> "Recent field studies indicate that a portion of the glacial drift in northern Illinois formerly mapped as Illinoian is Farmdale in age, the earliest substage of the Wisconsin stage. . .This drift is the uppermost drift in the northern half of Boone County, in all but small areas in southeastern and northwestern Winnebago County, in southeastern Stephenson County, in northern Ogle County, and in small areas in eastern Carroll and northern Whiteside County."

Two years later Shaffer (1956) extended the mapping of the Farmdale drift to the Driftless Area.

Subsequent studies by the present writers have led them to agree with Shaffer that there is drift of Farmdale age in northern Illinois but to disagree with his view that it extends to the Driftless Area. With minor modifications, they restrict the Farmdale roughly to the Pecatonica lobe of Hershey--thought by him during the 1890's to be Iowan, and ~~later~~ also by Leverett in 1899 ~~(1899,)~~ (pl. 12).

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*The name Farmdale was taken from the hamlet of Farmdale near the Farm Creek typesection.

Thus, the recognition of the Farmdale glacial substage, on the basis of the Farmdale loess, preceded the identification of the glacial drift-sheet itself.

Extent of the Farmdale Drift

The Farmdale drift is the surface drift over nearly 1000 square miles of northern Illinois and southern Wisconsin, westward from the Tazewell and Cary moraines to Freeport and Durand, Illinois, and nearly to Brodhead and Oregon, Wisconsin. ~~(See Fig.)~~. Other deposits believed to be Farmdale occur in a detached area west of Eau Claire, Wisconsin.

The Labradorean-Iowan drift overlaps the Farmdale of southern Boone and eastern Ogle counties, but patches of Farmdale emerge from it north of the village of Stillman Valley and northwest of the hamlet of Kings. No Farmdale drift is known south of Kings.

The Lemont drift of Bretz (1939, p. 52-53; 1955, p. 70-78) north of Joliet, is a plausible correlative, although Horberg and Potter (1955) have suggested that it may be Illinoian. If Farmdale, it would appear that the ice lobe that followed the Lake Michigan lowland ~~and~~ was ~~not~~ an appendage of the lobe that moved into the Rockford area.

Border features

The border of the Farmdale drift sheet lacks a terminal moraine as do also the borders of the Iowan and the Illinoian drift sheets. Its position, however, is based on patchy marginal accumulations, on pro-glacial lake sediments where the ice obstructed the inflowing drainage, and where there is a change in topography from the erosional of the Illinoian to the glacially modified of the Farmdale.

Illinoian outwash gravels occurring southwest of Rockford on the west side of Rock River at an elevation of 760-780 feet, as well as those on the east side, ~~recently~~ described by Leighton and Brophy (1963), were overridden by the Farmdale glacier, which came to rest against the old valley slope to the west and south. At a high knoll that occurs at the middle of the north line of sec. 31, T. 44 N., R. 1 E., Rockford quadrangle, the boundary turns westward and is indefinite for the next four miles to about one mile south of Winnebago where a low terminal ridge begins and extends westerly for four miles into the Pecatonica quadrangle to the valley of Grove Creek. South of Winnebago and again north of Seward the ice of the Pecatonica glacial lobe approached the summit of the rock divide which is the south boundary of the Pecatonica drainage basin, but to the westward it fell increasingly short of it.

The glacial front blocked the north-flowing upper reaches of Grove Creek 2 miles east by northeast of Seward causing a small marginal lake and an aggraded lacustrine flat, now overlain by Iowan loess and partially dissected. It also dammed the upper valley of Summer Creek, again causing deposition of lacustrine silts which can be seen in the north roadside ditch beneath Iowan Loess, along the south line of the SE¼ SE¼ sec. 17, T. 26 N., R. 10 E. (Fig.). Three feet of silt, sandy silt, and clays with an occasional pebble were observed separated from the leached Peorian loess above by 1 to 1½ feet of black soil. This soil correlates with the humus layer found widely in this stratigraphic position and which has recently been named the Farm Creek Intraglacial (Leighton, 1960). For reference purposes this proglacial lake is named Lake Seward, after the village of Seward, near which is the old outlet, at an elevation of about 870 feet A.T. in the SE¼ sec. 20, T. 26 N., R. 10 E. Northward this proglacial lake terminated at the ice front where glacial topography begins.

In the southeast corner of the NE¼ SE¼ sec. 13, T. 26 N., R. 9 E., near the south line of the Pecatonica quadrangle, at a point of land which the

the advance of the Farmdale glacier, an abandoned gravel pit shows ice contact gravels, boulders, and deformed and disarranged ledges of Galena dolomite. Westward from here, the hills in sections 13, 14, and 15, continued to impede the southward advance of the ice, while to the north the glacier was deforming the Galena strata.

Southwest of Evarts the glacial front blocked the upper reaches of Silver Creek creating pro-glacial Lake Silver, which ponded the area along the ice border for 5 to 6 miles (Fig.). The lake spilled to the southeast across the divide into Mud Creek about 1½ miles northwest of the village of German Valley. The outlet channel in the NW¼ sec. 30, T. 26 N., R. 9 E. has an altitude of about 850-855 feet (after subtracting the thickness of the Iowan loess).

In 1920 a roadcut and boring 1½ miles north of Baileyville revealed lacustrine deposits laid down in Lake Silver above weathered Illinoian drift, consisting of 2 feet of rudely bedded silts and black muck of Farm Creek intraglacial time. Iowan loess overlies them.

Proglacial lacustrine pebbly sands were also found in a roadcut 7 feet deep in the NW¼ NW¼ NW¼ sec. 30, T. 26 N., R. 8 E. Old humus of Farm Creek age was exposed beneath 5½ feet of Iowan loess at an elevation of about 845 feet A.T. A boring was made into the materials below for nearly 9 feet, penetrating 2½ feet more of the black layer, then 2 3/4 feet of calcareous sand. Morainal knolls of gravel and till mark the Farmdale glacial margin to the north.

Northwestward, other morainal knolls mark the margin to the northwestward across sections 14 and 11, T. 26 N., R. 7 E. Gravel pits in some of these show angular to subrounded cobbly gravel, mostly dolomite, overlain by a thin reddish subsoil and a dark soil. This ridge with its knolls crosses the large buried Ancient Yellow Valley, and has a summit elevation at this place of about 80 feet above

present Crane Creek 1½ miles to the east. The damming of Ancient Yellow River produced ~~an extensive~~ a large ephemeral proglacial lake to the west, to be described later.

The geographic position of the south border of the Pecatonica lobe was in response to the topography. The glacier remained confined to the north side of the high preglacial rock divide from south of Winnebago to Bunker Hill, in the northwest corner of the Oregon quadrangle (NE¼ sec. 19, T. 26 N., R. 9 E.). Here the divide swings southwestward which permitted the glacier to expand for nearly 2 miles to the south, across an intermediate bedrock surface, the Freeport strath.

The precise position of the western terminus through the city of Freeport is obscure, but the gravel knolls in the northwestern part of town and just beyond the corporate limits seem to mark the advance of the glacial lobe at least that far up the Pecatonica River Valley. An old pit in one of the low knolls shows poorly sorted ice-contact sediments ranging from silt to angular limestone blocks 1½ feet in diameter. On top of the hill across the valley to the northeast (NE¼ sec. 30, T. 27 N., R. 8 E.) an old pit 10 feet deep shows ice-deformed layers of fractured Galena dolomite dipping 20° S-SW, overlain and underlain by comminuted limestone flour with limestone fragments and pebbles of rounded Niagaran limestone, granite, basalt, and brown chert.

The northern limit of the Farmdale drift gradually rises eastward from spur to spur from below 840 feet A.T. to 920 or more, the glacial front entering the recesses of the larger tributaries of Pecatonica River.

A large kame-complex occurs in sec. 19, T. 27 N., R. 8 E., which was made during the initial melting of the glacier. It is an ice-contact deposit with angular to subangular cobbles up to 10 inches in diameter, and the bedding dips northward. The ice-contact surface on the south side bears out the concept of the radial movement of the Pecatonica lobe. Gravel is repeatedly exposed along the east-west road that crosses the hummocks, but near the foot of the slope, eastward, rock shows in a shallow road cut. It is suspected of being a glacially

transported dolomite ledge, like the many large ones known south of the river.

Two miles to the northeast, near the east line of the Freeport quadrangle, in the SW¼ SW¼ NE¼ of sec. 30, T. 27 N., R. 9 E., a roadcut exposes 2 feet of salmon-colored sandy silt, lying over Farmdale till, and separated from the yellow Iowan loess above by a carbonaceous horizon of Farm Creek age. The sandy silt is not the normal Farmdale loess and is here interpreted as a marginal periglacial eolian deposit. ~~Although~~ Shaffer (1956, p. 20) also believed it to be a local eolian ~~accumulation, he could not regard it as periglacial because he held that the glacial front reached the Driftless Area 30 miles to the west before becoming stagnant.~~ feature.

The glacial margin is also marked in places by hummocks of gravel, ~~or~~ as on the north slope of Pecatonica River valley wall, one-half mile to the east, in the SW¼ NW¼ of sec. 29, T. 27 N., R. 9 E. About 2 miles north by northeast of Ridott, within the valley, in the SE¼ of sec. 27, a kame 30 to 40 feet high is surrounded by a valley-fill of back-water silts laid down during Cary times. Hence, the kame belongs to deeper-lying Farmdale glacial debris in the valley.

Two and a half miles east-northeast of Ridott, in the NW¼ SW¼ SE¼ of sec. 26, T. 27 N., R. 9 E., a gravel pit in 1920 showed ice-contact deposits including bedded silt, sand, and cobbly gravel, with some beds intricately contorted, in juxtaposition with slabs of Galena dolomite and small included masses of pink till with some decayed pebbles, probably gathered up in a frozen condition from older drift deposits. Igneous and quartzite boulders, which had probably been extracted from the pink, occurred nearby.

The wide downstream portion of Rock Run and Pink Creek, in the Pecatonica quadrangle, enabled the glacier to reach as far north as the mouth of Brown Creek where that stream was diverted across a low bedrock divide where it became incised. North by northeast of the village of Pecatonica, the short stubby tributaries of Pecatonica River also show the effects of glacial entry. In the capacious basin of Otter Creek, the ice extended westerly to a point about 1½ miles west of Durand. The inflowing drainage was impounded and for a brief time this pro-glacial lake,

here named Lake Durand, overflowed across the 900-foot rock divide 2½ miles southwest of Durand.

To the north of Durand, where the glacier barely overtopped the 950-foot rock ridge and impounded Lake Brodhead, the drift boundary swings to the northwest and crosses the broad Sugar River Valley to the vicinity of Avon, Wisconsin. The low bedrock surface at Orfordville permitted a lobate extension of the glacier westward into Sugar River Valley.

Glacial deposits in the Durand area and to the northeast are fresher than the Illinoian, the slopes are smoother, and there is no Farmdale loess. The higher rock slopes, however, have scanty drift and no glacial features other than smooth contours.

In 1962, a new roadcut at the southeast corner of sec. 36, T. 29 N., R. 10 E., showed two tills separated by a disturbed zone of weathering, and glacial topography occur nearby. The two tills are referred to the Farmdale and Illinoian.

On the 800-foot ridge in the NE¼ NE¼ sec. 25, T. 29 N., R. 10 E., Pecatonica quadrangle, a dolomite sand pit shows very badly crushed dolomite, so ~~much so~~ comminuted that it was possible for the operators to secure dolomite sand by selective quarrying. This crushing cannot be referred definitely to either Farmdale or Illinoian glacial overriding.

Badly ruptured and disturbed brown limestone is also exposed in a small quarry along the south line of the SE¼ of sec. 22, T. 29 N., R. 10 E. Glacial topography also occurs in the short broad valley about one-half mile to the west which is thought to be within the Farmdale drift area. Later valley fill of Cary age doubtless buried most of the morainal features that were in Sugar River Valley.

In his report of 1918 (p. 140, 141) Alden notes that drift in this part of Wisconsin is generally thin on the crest and higher slopes of the ridges but that numerous wells, in the valleys of the area which are here mapped as Farmdale,

"are reported to have penetrated 60 to 240 feet of drift before reaching rock." He notes also that northeast of Newark (one mile east of the Farmdale drift boundary as herein drawn) there was glacial diversion of the headwater drainage of Raccoon Creek, and that at one point 3/8 of a mile west of Newark corners, a well penetrated 40 feet of drift to rock. The present senior author recently found bouldery gravel in an abandoned pit ½ mile to the west, still closer to the Farmdale boundary, and Alden cites another well on a knoll on the ridge, at the border, that went through 58 feet of drift to rock. Large igneous boulders occur along the road near the Farmdale margin, ~~which is well established~~.

Alden shows on his plate 15 (B) strikingly fewer rock outcrops within the writers' Farmdale drift area than in the Illinoian drift area to the north and northeast of Avon. A morainal belt of gravel hills bounds the lobe northeast of Broadhead, and kames also occur on a morainal ridge about one mile northwest of Orfordville. Alden (p. 141, 142) also describes a toppled rock pillar about 3 miles west of Orfordville, within the present Farmdale boundary, one that is similar in origin and form to the pillar still standing in the Illinoian drift area northwest of Footville. The toppled pillar is within the Farmdale drift area and is believed to have been laid prostrate by the Farmdale ice.

Alden also records a thick 140-foot section of drift in the section northeast of Footville, in the area here mapped as Farmdale. The Janesville and Evansville topographic maps clearly show the drainage lines of the Farmdale drift area to be much more disorganized than those in the Illinoian drift area.

The Farmdale drift disappears beneath the Cary drift about 5 miles west of Oregon, Wisconsin, near where Alden drew the Illinoian boundary (see Fig.). The Farmdale tract has morainal patches ~~such as Alden describes as lying~~ northwest of Magnolia, ~~the~~ gravel deposits ~~situated~~ two miles southwest of Evansville, ~~the~~ a deposit of drift in sec. 30 of Union Township (T. 4 N., R. 10 E.), ~~that~~ which Alden says "lies against the east slope of the rock ridge with a somewhat definite margin," and

a
~~the~~ morainal ridge in sec. 13 of Brooklyn Township (T. 4 N., R. 9 E.).

Northwest of Janesville, in Farmdale glacial topography, Alden obtained the record of a well that shows about 100 feet of gravel over ten feet of red clay, beneath which is a pebble conglomerate 8 inches thick and 40 to 50 feet more of sand and gravel on bedrock. The red clay may well be a weathered zone of Illinoian drift beneath which the gravel has been cemented.

History of the ephemeral pro-glacial lakes

The draining of Lake Broadhead, ~~shown in Fig.~~ (see Fig.), had an interesting history which began when the Farmdale glacier became stagnant. The Juda outlet at 920 A.T. bears evidence of having been used for but a brief time, making it appear that the ice wasted promptly from against the high rock ridge north of Durand. The level fell to the900-foot stage which was held by the Davis outlet 3 miles southwest of Durand. In the Freeport area melting promptly opened the 855-foot German Valley outlet which caused the Pearl Lake outlet at 865 feet A.T. to become abandoned, and the two lakes, Lake Pearl and Lake Freeport, became one, Lake Pecatonica. Lake Broadhead became an extension of Lake Pecatonica after the Farmdale ice had melted from the high hills southeast of Durand.

Decadent as the stagnant ice was, it was not long before the Westmoreland 805-foot outlet northwest of Rockford functioned. Through it flowed the waters of Lake Pecatonica that had previously gone through German Valley as well as the waters of the small new Lake Raccoon.

The ~~outlet waters~~ first escaped southward around the west edge of the present site of Rockford to South Fork of Kent Creek, thence to Rock River. Later the melting of the ice opened a lower channel through the narrow gap now occupied by the North Fork of Kent Creek and across what is now the business section of Rockford to Rock River. Final drainage of Lake Pecatonica took place when the

junction area of Pecatonica and Rock rivers and the valley segment of Rock River downstream were cleared.

Contrasts in the Topography of the Farmdale Drift Area

East of Rock River.--The topography of the Farmdale drift east of Rock River, which was formed under the main mass of ice, contrasts with the topography to the west, which was shaped by the thrusting power of the glacier during its advance. East of Rock River a field of low narrow drumlins interrupts an otherwise flat, youthful terrain, while to the west the landscape is diversely rolling with occasional glacial contours.

The low drumlinoid ridges have a striking sub-parallel orientation of S. 50°W. in the area east of Rockford, changing to S. 65°W. near the Illinois-Wisconsin State Line. They are miniature drumlins compared to those of the Green Bay Lobe of Cary age. Even so, they give grain to the topography, indicate the direction of glacial movement, control the direction of headward erosion of tributaries from Rock River, and limit the size of their basins. Their extent to the southward is limited by the "break" to a lower surface, the valley fill of Ancient Troy River, once a major tributary of Ancient Rock.

The east valley wall of Rock River north of Rockford owes its prominence partly to high bedrock and partly to overlying glacial deposits. West of the pre-Farmdale rim of the valley and down the valley slope, Farmdale drift overlies a former 780-foot terrace of the Illinoian coarse sand and gravel valley train. Then the Farmdale glacier descended into the broad valley, crossed it, and confronted and eroded the west rock wall and spread the debris over the dissected topography to the west.

West of Rock River, there are two natural subdivisions: (1) the Pecatonica glacial lobe which follows Pecatonica River westward to Freeport as shown in Fig. , and (2) the area from Durand north into Wisconsin to the

Johnstown moraine and its outwash deposits. The Pecatonica lobe, which Hershey could outline only roughly because of poor maps, is here treated first.

The low west valley wall of Rock River begins abruptly, as expected, at the south boundary of the glacial lobe, some 4 miles south of Rockford, and the low wall continues northward for the rest of its ~~continuation~~ course. The summit is 40 feet or more lower than the buried rock rim of the east side and 40 to 60 feet below the uplands to the west. Some of this erosion may possibly be attributed to the previous Illinoian ice sheet~~, though such erosion is less noticeable to the south.~~

The west valley wall of Rock River was clearly vulnerable to glacial erosion because it stood directly in the path of the glacier, and because the strata of the Galena formation had been weakened by solution along joints and bedding planes during pre-Quaternary times. The drift to the west reflects this tremendous denudation by its coarse, fragmental character, and high carbonate content. No other drift sheet in the Mississippi Valley has such a distinctive physical and chemical composition, from which a particular type of weathered zone was later produced. This is a matter that appears to have ~~has~~ been completely overlooked ~~by most workers.~~

As already noted, two spillway channels crossed the Farmdale drift area as the glacial ice proceeded to desert the area, the more western and higher one 4 miles southeast of Freeport, the other and more prominent one, 6 miles northwest and west of Rockford. While the ice front lay to the ~~lay~~ east of the latter, deposits were made beneath it and at its margin which ~~under the conditions then prevailing which~~ gave the topography certain features at variance to those to the west. Among them are crevasse fillings--small, fairly straight ridges of ice-contact stratified drift in summit positions, most of which are under 30 feet in height, about 1/8 mile wide, and less than one mile long.

The most chaotic features of the Farmdale drift, however, west of Rock River, are found in a 30 square mile area, from the longitude of Winnebago

To be appreciated,

west to Silver Creek Valley, east of Freeport. They must be studied in the field with topographic map in hand, and supplemented by observations of the deformed and detached strata in quarries and pits distributed over the area. These unusual features ~~Such~~ make it evident that the Farmdale glacier carried out mass dislocations of the upper portions of the rock divides.

An outstanding example is a high east-west elongate hill just east of Silver Creek, 4 miles east by southeast of Freeport (center sec. 12, T. 26 N., R. 8 E.). This hill has the form of a long drawn-out glacial feature (see Freeport topographic map), is one mile long, 1/5 mile wide, has a rounded summit, and stands 60 to 80 feet above Silver Creek.

The face of a large quarry truncates the west end of this hill and shows the intimate and complex relationships of the disordered masses of Galena dolomite, comminuted rock, and glacial till. When described and sketched in 1956, there was a large mass of detached rock at a (Fig.) about 100 feet long with an exposed thickness of 18 feet above the basal debris. It was juxtaposed on the right against an unrelated thin-bedded rock mass, with a thin body of till separating their upper portions. A large mass of till, b, nearly 90 feet long, was vertically exposed for 15 to 25 feet. To its upper left at c, was a mass of crushed rock nearly 40 feet wide at the top and exposed to a depth of 12 feet, the constituents ranging from dolomite flour to 3-foot angular blocks. To its left was an enormous mass of slabby till, d, in which rock strata are tilted at various attitudes. The matrix was largely dolomite flour, pale salmon in color when moist like the Farmdale, and which contained a heterogeneous mixture of erratics. On the floor of the quarry pit were blocks of dolomite up to 8 by 6 feet in size. At e, at the top of the quarry, there was a small ledge of dolomite with nearly horizontal layers. If such a ledge were exposed in a shallow cut without disclosing the underlying till, it might well be interpreted as bedrock in situ and used as a datum point for mapping the bedrock surface, which would be erroneous.

That this eminence which projects westward from the upland, and which is composed of such a heterogeneous assemblage with no water-laid sediment but containing large disrupted masses of bedrock, tilted and disarranged, bears indisputable evidence of mass glacial plucking from the bedrock hills to the lee, cannot be questioned. The texture of the materials bears evidence of only incipient glacial comminution, very limited transportation, and but brief handling.

Other exposures ~~record~~ also reveal how severely the glacier deformed and disrupted these hills of eroded and weathered Galena dolomite. One of these was observed in a quarry one-half mile east of Ridott corners (sec. 4, T. 26N., R. 9 E.) in 1920, at which time it was sketched and described by the senior author (see Fig.). In the main quarry face, there was a striking synclinal structure of glacially deformed Galena dolomite which showed dips up to 37 degrees. To the left was a semblance of an anticline, b, the central portion of which contained crushed rock; at its left, a remnant of a small recumbent syncline. These structures occurred within a lateral distance of 150 feet. On the right at d were two masses of rock of different structures. Below a portion of the main quarry floor a new pit had been excavated 12 feet deep with a face 70 feet long. Here was a glacially produced anticlinal fold of Galena dolomite almost directly beneath an overlying glacially made syncline! Beds 4 to 14 inches thick were involved. Obviously the overlying structure had been shoved over the lower.

In the face of another quarry 8 miles to the northeast, in the NE$\frac{1}{4}$ NW$\frac{1}{4}$ SW$\frac{1}{4}$, sec. 33, T. 27 N., R. 9 E., Pecatonica quadrangle, similar distortions were seen. On the north and south sides were tilted Galena strata with westward dips of 10° to 90°. The dipping layers were separated in places by contorted masses and in places thin rock layers had been thrust over them. Beneath the bedrock on the north side was a till-like stratum containing igneous pebbles and dipping south about 8°. There was no till on top of the rock, only a scattering of pebbles.

From Freeport to well beyond Pecatonica, the south valley wall of Pecatonica River is unlike the north wall. Besides being characterized by glacial anomalies, such as those already described, it bears no suggestion of the high bedrock terrace or strath which occurs southeast and south of Freeport, westward along the Ancient Yellow River, and northwestward along the Pecatonica River. Its importance in the geomorphology of the region warrants a name--Freeport Strath. Its surface is at about 800 feet A.T., approximately 100 feet below the general upland. It clearly represents a stage in the late Tertiary cycle of erosion of this region when the Ancient Yellow was the master stream. It may well be the correlative of Hackett's (1960) buried strath at the junction of Pecatonica River with Rock River. The transfer of large masses of Galena bedrock by the Farmdale glacier appears to have so buried it and so modified it that it is east from the mouth of Silver Creek no longer a feature of the ~~topography~~ valley.

In this connection, the short but capacious trough-like depressions such as the one north of Ridott Center School have a special significance (see Fig.). The intermittent stream, Wickham Creek, which occupies it could not have eroded this valley, for it is less than two miles long but has a width of nearly half a mile. Its slopes also bear glacial swells and knolls. The topographic map shows similar stubby troughs all along the south margin of Pecatonica River Valley from Silver Creek eastward to Coolidge Creek. They are clearly glacial in origin, though not due to glacial carving because their trends vary nearly 180 degrees. They occur in the submarginal depositional zone of the glacial lobe.

The ridges between the troughs are in part distorted masses of bedrock and glacial drift carried down onto remnants of the Freeport strath. The constriction of Pecatonica Valley begins east of Silver Creek where the trough-like depressions begin to appear, the depressions resulting from the melting of portions of the clearer ice in close association with more heavily freighted portions.

Other disruptive effects of the Farmdale glacier are apparent on the topographic map where the stream divide patterns ~~are deranged~~ show derangements, as south of Pecatonica (see Fig.). Grove Creek clearly shows notable stream diversion. In the upper portion it drains a large area in normal fashion, then it leaves its basin to flow westward across the rock divide in which it has become incised. The small ridges on the summit areas trend parallel to the direction of glacial movement and are probably made of drag debris. These bizarre features reflect a combination of rigorous glaciation followed by deposits from ~~a glacier~~ the ice after becoming stagnant.

North of the State line the Farmdale topography is less chaotic than that of the Pecatonica lobe, yet strikingly different from the Illinoian drift area to the west. Alden (ibid, p. 140-144) singled out the tract between Rock River and Sugar River as being different from the tract west of Sugar River (ibid, p. 144) but did not postulate a later glaciation. He recognized the promiscuous type of topography between the two rivers, the diversions in drainage, the numerous disconnected morainal patches, and the local occurrences of thick drift. He also noted the contrasting thinly drift-mantled, eroded area west of Sugar River.

The wide flood plains of Sugar River and its tributaries and also of Rock River itself stand out in contrast to its constriction in the downstream portion below Rockford. These are due in part to a large ancestral stream, partly to the incoherent properties of the St. Peter sandstone, and partly to the backwater fill behind the Rock River Valley train of the Green Bay glacial lobe. As for the tract between Rock River and Sugar River, one cannot escape the conclusion that the tract was glaciated in Farmdale times.

Direction of glacial movement

The axes of the drumlinoid forms of the Farmdale drift east and northeast of Rockford, indicate a S 50°W. to S 65°W. direction of movement for the

basal ice as it moved into Illinois. West of Rock River, the flow of the Farmdale ice was radial for the Pecatonica lobe as shown by striae and trends of crevasse fillings and eskers. The main axis of movement of the lobe was about S 75°W, and striae on the south side of the axis, at an old quarry in the SE¼ SW¼, sec. 28, T. 44 N., R. 1 E., (Rockford quadrangle) trend S. 65°W. (Fig.). It is interesting that old shallow cross solution pits on the layer of rock were not removed, the glacial planation was so slight. The glacier, in fact, reached only one mile to the west. Radial flow is also suggested here by the curvature of a nearby esker 30-40 feet high, which changes course from east-west to southwest in its length of one quarter of a mile. Buell (1895) reports striae in a quarry seven miles to the west (2 miles northwest of Winnebago) trending S 75°W.

But eskers, like drumlinoid forms, are more assuring than striae where more than one glaciation is involved. A small esker north of the axis of the lobe (3½ miles southeast of Harrison) trends N. 50°W. Two miles to the south an esker one mile long curves from east-west to northwesterly, and 2 miles to the southwest another esker which is near the axis of the lobe trends S. 75°W. Farther west three eskers on the north flank of the lobe, all in the Pecatonica quadrangle, have significant trends. One in sec. 17, T. 27 N., R. 11 E., trends N. 80° W., another in secs. 32, 29, and 30, same township, trends east-west and then turns N. 45°W., and a third in sec. 34, T. 27 N., R. 10 E., trends N. 70°W. and then turns even more northwesterly. These eskers have summit positions in the topography and are believed to be related to crevasses resulting from tensional forces in the spreading ice lobe.

The general direction of movement of Farmdale ice was southwesterly whereas the Illinoian was northwesterly. Striae made by the former at Rockford trend S. 65°W.; those by the latter in the NW¼ NE¼, sec. 24, T. 24 N., R. 9 E., Oregon quadrangle, trend N. 83°W., ~~west of Rockford, which trend to the northwest, S. 75°W.~~

Glacial Outwash

Moving against the drainage, the Farmdale glacier issued no valley trains except down Rock River of which more remnants survive. Instead it was productive of proglacial lakes heretofore described. The fluvial outlet of Lake Brodhead carried neglible sediment into Lake Freeport. But Lake Pearl which bordered briefly some of the glacial front received a thin deposit of lacustrine sediments. It has little in the way of shoreline features but there are incipient and disconnected flats between 840- and 860- foot contours and a faint topographic break with local pebble concentrates at about 860 feet A.T.

It should be noted in this connection that the backwater silts and sands in the small 760-770 foot A.T. terraces in tributaries of Pecatonica Valley are of Cary age and are not to be confused with Farmdale sediments. The deposits of silts of Cary age probably bury any remnants of the much older Farmdale silt. It should also be noted that when the German Valley outlet to the southeast, to Rock River, was opened no Illinoian ice could have been existent.