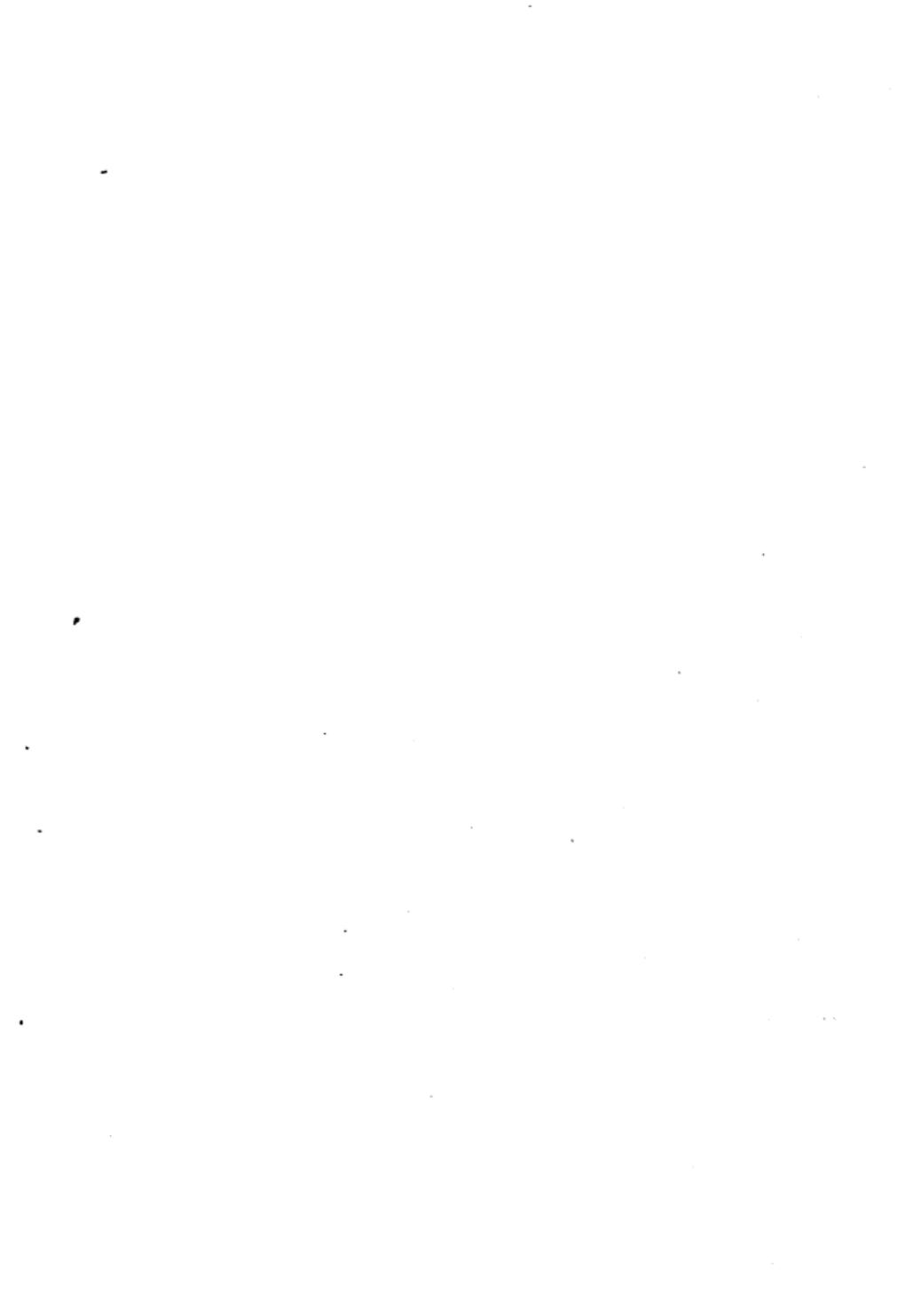

BURIED RIVER CHANNELS IN SOUTH-
EASTERN IOWA.

BY

C. H. GORDON.



BURIED RIVER CHANNELS IN SOUTHEASTERN IOWA.

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Reference was made long ago* to the great development of glacial material along the west bank of the Mississippi river in the vicinity of Fort Madison. The existence of an old valley in that vicinity was, however, first made known by Major G. K. Warren, in 1878.† Although the conclusions arrived at were based entirely upon observations made at the surface, they have been confirmed in all essential points by later investigations. At that time no data bearing upon the depth of the channel were available.

In 1890, without knowing of Warren's work, the author reported the existence of an ancient course of the Mississippi between Montrose and the Des Moines river.‡ A map corresponding in all essential respects with that of Warren's accompanied the announcement, and additional details were given bearing upon the depth of the channel. Recent investigations have not only confirmed previous conclusions, but added much to the knowledge of the change of drainage here recorded.

Stratigraphy.—The indurated rocks exposed in Lee county belong chiefly to the Lower Carboniferous series.

*Geology Iowa, Vol. I, p. 187. 1858.

†Bridging of the Mississippi, Annual Report Chief Engineers for 1878. Appendix X, p. 3.

‡Paper read before the Geological Society of Chicago. Not yet published.

They are, however, overlain in places by more or less extended outliers of the Coal Measure formation. In the interval comprised between the deposition of the Lower Coal Measures and the beginning of the Ice Age, this region must have been above sea level for a long period of time, as shown by the extensive denudation and channelling which the rock surface has suffered. The evidence appears conclusive that the Coal Measures, and possibly later formations, originally extended over the whole of the area, but of these there now remains only the small detached areas of the former, preserved by some fortunate circumstances of position or structure. The general surface of the indurated rocks, irrespective of the channels, though corresponding in the main with the land surface, is much more irregular. At Keokuk it has an elevation of 610 feet. It rises toward the north, attaining an altitude of 625 feet at Nashville, 640 feet at Donnellson, and about 675 in the vicinity of Saint Paul. Upon this uneven surface drift has been spread in sufficient amount to fill the depressions and raise the surface forty to sixty feet above the highest rock level. The result has been a gently sloping plain, dissected more or less by subsequent drainage.

Topography.—West of East Sugar creek the plateau slopes to the southeast, descending from about 700 at Donnellson to 656 feet at Keokuk. The average slope is thus about two feet per mile. The plateau has been reduced on the west by drainage leading into West Sugar creek, while its eastern margin has been cut away in part to form the Viele terrace plain. The divide which separates the two drainage systems is marked on the map by the line of the Keokuk & Northwestern railroad between Moar and La Crew. The profile of this road gives the following elevations :

	FEET.
Donnellson.....	696
Charleston.....	694
New Boston.....	689
Mount Clara.....	679
Summitville.....	670
Keokuk (level of plateau).....	656

The summit of the divide west of Montrose lies just at the top of the bluff's which form the eastern border of the plateau. A comparatively broad and deep trough leads from the bend of Little Cedar creek, southwest of Salem, to the Mississippi, at Viele.*

This valley, which has been traced a considerable distance beyond the limits of Lee county, is chiefly, if not entirely, confined to the drift, and hence has its origin at least subsequent to the withdrawal of the first ice sheet. The newer channel of East Sugar creek lies within the older one. In places this stream flows above or upon the floor of the older valley, while in other points it has cut twenty-five feet to forty feet into the underlying Saint Louis limestone. Most of the old bottom is floored with rock at a slight depth, but at several places drift intervenes. Six miles directly west of Fort Madison (Tp. 68 N., R. V. W., Sec. 32, W. $\frac{1}{2}$) there is a remnant of the old valley bottom in the form of a ridge fifty feet high, and composed of boulders, chiefly of limestone, more or less firmly cemented together. The top of this ridge has an elevation of about 600 feet, while at the bend of Little Cedar the old valley lies about 660 feet above sea level. This shows the comparatively rapid fall of sixty feet in a distance of about fifteen miles.

East of this old valley the plateau has a greater elevation than towards the west, and along the crest of the

* Acknowledgement is due Mr. Frank Leverett, who has freely contributed notes and suggestions.

divide between East Sugar creek and Skunk river is a group of low irregularly distributed mounds marking the location of a moraine. West Point, which is somewhat above the general plateau level, has an elevation of 762 feet, while at its border above Fort Madison the plain lies about 700 feet above sea level.

South of Skunk river for a distance of two miles the bluffs on the west side of the present valley coincide with the limits of the old channel. They then gradually approach the river, which washes their base just above Fort Madison. The triangular area of bottom lands thus set off occupies nearly the whole of Green Bay township. Towards the river it is low and abounds in sloughs. It rises gradually towards the west in a series of sand terraces to a height of about sixty feet at its western border. The terrace on which the station at Wever is situated is forty feet above low water at Fort Madison. Below the latter place the bluffs again recede from the river, leaving another terrace plain of crescentic outline cut off below by the approach of the bluffs on the river bank at Montrose. Viele station, which is situated near the outermost border of this plain, has an elevation of thirty-three feet above low water at Montrose. In this portion of its course the river flows upon drift, and is characterized by sandbars and sloughs. It has a fall of two feet only for a distance of nine miles. From Montrose to Keokuk it is confined within a narrow, rockbound valley with precipitous slopes, and flows over a rocky floor. The river has a fall of twenty-three feet between these places, or a little more than two feet per milé. This part of the course is known as the lower, or Des Moines, rapids. South of the Des Moines river, the Mississippi occupies a uniformly broad, alluvial valley.

At Sand Prairie, a sand plain similar to the Viele terrace plain intervenes between the river and the bluffs on the left, and another but smaller one occupies most of sections 29, 30, 31 and 32 (Tp. 65 N., R. V. W.). Between these the river flows at the base of the bluffs which in section 30 (Tp. 65 N., R. V. W.) are especially prominent and are called the "Yellow Banks." Above Sand Prairie the river valley is comparatively narrow and bounded by more or less precipitous rock escarpments. From Farmington to its confluence with the Mississippi the river has a fall of about two feet per mile.

At "Yellow Banks" the bluff rises about ninety feet above the adjoining bottom lands. The following section was obtained here :

Yellow Banks Section.

	FEET	INCHES
8. Clay, yellow, pebbleless.....	5	
7. Silt, drab, pebbleless.....	1	3
6. Earth, black, with a few small pebbles; apparently an old flood plain deposit.....	12	
5. Clay, yellowish (local).....		6
4. Sand, with a few small pebbles; layer of boulders one foot thick as base.....	20 to 25	
3. Earth, black, with yellow streaks; apparently old flood plain deposit.....	5 to 6	
2. Gravel, with some sands; pebbles two inches or less in diameter.....	20	
1. Clay, blue till (exposed to level of railway)	15	

About a mile west of this locality at the mouth of West Sugar creek the top of the blue till is about on a level with the railroad track. The sand and gravel above is considerably indurated and a distinct plane of junction between the sand and the clay evidently represents an erosive surface. The section at Yellow Banks with the exception of number 2 represents alluvial deposits and the

bluff the extremity of a terrace plain. Northward from the "Yellow Banks" this plain occupies sections 18 and 19 with portions of adjoining sections east of the creek. West of the stream it occupies the interval between the creek and the river northward to Melrose chapel. On the north and east this plain is bounded by a low bluff rising twenty-five or thirty feet to the general plain level. This terrace plain has suffered a slight reduction towards the river. It has not been traced above Melrose chapel, but a well defined terrace probably to be correlated with this appears at intervals along the Des Moines. At Keosauqua a series of terraces extends up to a height of 135 feet above the river.

OLD MISSISSIPPI CHANNEL.

Location.—The limits of an ancient valley which was once occupied by the Mississippi river are indicated approximately upon the accompanying sketch map (figure 5). Between the mouth of Skunk river and Montrose the present valley lies within the older one and adjacent to its eastern margin. Also below the mouth of the Des Moines river ten miles distant the present valley represents a revival in part of the earlier channel. Between Montrose and the mouth of the Des Moines river, however, the river flows in a rockbound gorge which runs from four to five miles east of that of its former course.

Limits of the Channel.—No rock exposures appear within the area occupied by the channel as indicated upon the map. Usually the wells of the region fail to penetrate the drift, but at Fort Madison and Mount Clara deep borings have been made which pass completely through the drift and continue several hundred feet into the indurated rocks (figure 6). Above Montrose, rock outcrops

along the eastern bank of the stream mark approximately the eastern boundary of the old valley. In a southwest direction from the town no rock appears until the Des Moines river is reached. At the mouth of this stream, on the north side, the limestone stands 100 to 140

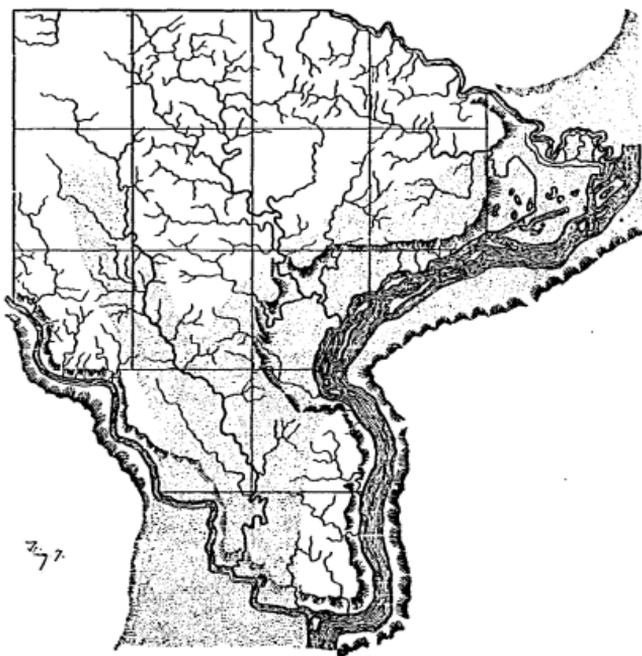


Figure 5. Sketch Map of Lee County, showing courses of old Channels.

feet above the level of the river. About one and one-half miles to the west the Keokuk formation outcrops at the base of a hill fifty feet high, lying between the railroad and the river. From this point to Sand Prairie the bluffs are composed entirely of unconsolidated materials. At the latter place the Saint Louis limestone makes its

appearance in the bluffs, of which it constitutes a prominent feature for many miles. Northward from Sand Prairie the limits of the channel are marked approximately by outcrops at the following localities:

1. Painter's creek (Tp. 67 N., R. VI W., Sec. 13).
2. Railroad bridge over East Sugar creek (Tp. 67 N., R. V W., Sec. 5).
3. Lost creek (Tp. 68 N., R. IV W., Sec. 6).
4. Skunk river (Tp. 69 N., R. III W., Sec. 32).

Well Records.—Several deep wells have been put down at Fort Madison, all of which agree in showing a great thickness of clay and sand below the level of the river.

*Paper Mill Well, Fort Madison.**

	THICKNESS.	DEPTH.	ELEVATION TO SEA LEVEL.
5. Loam, black, quicksand and blue clay; not separated in the record.....	145	145	379
4. Limestone.....	35	180	344
3. Shale, blue and white.....	250	430	94
2. Limestone.....	180	610	-86
1. Sandstone (water-bearing rock). 77		687	-163

The surface at the well is twenty-one and one-half feet above low water datum, or 524 feet above sea level.

At the Atlee well, where the surface is thirty feet higher, the depth to limestone is 190 feet, while at the Hospital well, where the elevation is about the same as at the Atlee, it is 185 feet. A comparison of these figures shows a variation of fifteen feet in the elevation of the rock plain, due doubtless in part to irregularities in the old surface.

* This record was obtained from Mr. Frank Leverett, for whom it was copied from the books of the Fort Madison Paper Company, by the secretary, Mr. A. P. Brown.

At Mount Clara, two miles west of Montrose, a well has been put down at the summit of the divide on the farm of W. J. Beck.

Mount Clara Well.

	THICKNESS.	DEPTH.	ELEVATION TO SEA LEVEL.
12. Clay.....	250	250	429
11. Sand.....	55	305	374
10. Limestone.....	25	330	349
9. Shale, blue.....	8	338	341
8. Limestone.....	5	343	336
7. Shale.....	325	668	-11
6. Limestone.....	115	783	-104
5. Limestone.....	10	793	-114
4. Limestone, flinty.....	25	818	-139
3. Limestone.....	40	858	-179
2. Limestone, hard.....	5	863	-189
1. ? No sample; carried away by water.....	76	939	-260

The well is on a level with the station, which is 679 feet above sea level.* The rock is here 305 feet from the surface and has an elevation of 374 feet above sea level, or five feet lower than at the Paper Works. The two wells are about eleven miles apart.

Extent of the Old Valley.—The old channel has an estimated width of about six miles. At Fort Madison it has a depth of 123 feet, at least, below low water level, and at Mount Clara it is 126 feet below low water at Montrose. The elevation of the rock surface is about 620 feet above tide at Sonora, and at Keokuk slightly less. On this basis the amount of rock excavation in the old channel is 245 feet as compared with 135 feet in the new one. The relation of the two valleys are shown in the accompanying section from the Sonora quarries to Argyle (figure 6).

*Record furnished by the owner.

In considering the data bearing upon the depth of the channel, it is to be mentioned that a possible source of error may arise in the difficulty of distinguishing in a well boring between glacial clay and the shale of the Kinderhook group. At Burlington, about sixty feet of these shales appear above the level of the river. The strata descend quite rapidly toward the south and then, together with the overlying Burlington beds, disappear below the level of the river just above Fort Madison. While admitting, therefore, the possibility of such a mistake in identification, yet that no such error has been made

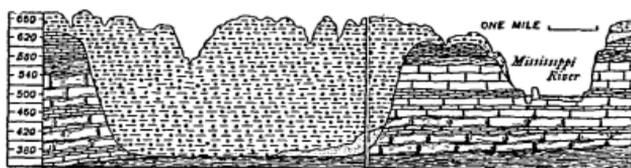


Figure 6. Cross-Section from Sonora to Argyle showing old and new Channels of the Mississippi River.

would appear from the following considerations: (1) the wells at Fort Madison and Mount Clara, while showing agreement in all essential points, were put down by different people; (2) the persons putting down the latter well were personally known to the writer as experienced well men who would be quite unlikely to make the mistake suggested; (3) the most conclusive evidence is the presence at both places of a great thickness of shale below the clay and separated from it by thirty to forty feet of limestone. A comparison of the records with those of wells at adjacent localities, as at Keokuk, Hamilton and elsewhere, leaves little doubt that the shales represented by number 3 of the Paper Works well and number 7 of the Mount Clara section are to be correlated,

in part at least, with the Kinderhook beds, while the limestone above probably represents the base of the Augusta.

ANCIENT DES MOINES CHANNEL.

The existence of a buried channel tributary to that of the Mississippi and corresponding in position to the Des Moines river, was first suggested in 1893. Though incomplete, sufficient evidence has been gathered to warrant the conclusion that, in the vicinity of Argyle, an old valley of considerable magnitude joins that described above. Its position is marked approximately by the present course of West Sugar creek. It has been noted already that above Sand Prairie the present channel of the Des Moines river is comparatively of recent date. The indurated rocks which form bold escarpments along the stream, however, are almost entirely wanting on West Sugar creek notwithstanding the fact that the valley of the latter south of the Chicago, Burlington & Kansas City railroad extends considerably below the level of the rock surface. The only exception is a limited exposure of Saint Louis limestone occurring in Tp. 67 N., R. VI. W., Sec. 5, about one and one-half miles southwest of Donnellson. At this place the limestone forms the bed of the broad shallow ravine opening into the valley from the east. The upper line of the exposure is estimated to be at least fifty feet above the bottom of the valley adjacent. It is evident, therefore, that West Sugar creek is engaged in reviving an older valley, the limits of which are as yet but imperfectly known. The only deep drilling known to have been made within the limits of the channel is on the Bell farm, one and one-half miles east of Big Mound. The record of this well could not be obtained, but it is reported to have been abandoned on account of the unusual thickness of the

drift and the difficulty encountered in penetrating it. The location of the channel is indicated provisionally upon the map.

HISTORY OF THE DRAINAGE DIVERSION.

The extent of the channels here recorded may be taken as in some degree a measure of the vast denudation which the region suffered previous to the Ice Age, while the evidence as to the cause leading to their abandonment must be sought in the deposits made during that period. The evidence at hand seems to warrant the assumption that at least two ice movements are recorded in the deposits of the region, one from the northwest and another and later from the northeast.

Des Moines Lobe.—The position of the new channel indicates that the obstruction which forced the river out of its old course must have been introduced from the northwest. Moving down the old valley of the Des Moines, it probably occupied the whole of the region between the Skunk and Des Moines rivers, and pushing across the old valley of the Mississippi as far as Keokuk, effectually dammed the stream and caused it to seek a new course farther east. Whether the movement here recorded was the first ice invasion is not clear, but it would seem that it was the first of sufficient magnitude to cause a marked change of drainage.

Later Movements.—From some of Mr. Frank Leverett's investigations in eastern Iowa, the results of which are soon to be published, there is reason to believe that an invasion of the Illinois ice lobe occurred long subsequent to the first displacement of the river. The limits of this movement are recorded in a morainic ridge extending south from New London in Henry county, entering Lee

county near Pilot Grove and passing through West Point to the river north of Viele. From this point to Warsaw, Illinois, its position is not clearly determined. Aside from its general relations evidence of its connection with the Illinois invasion is found in the presence of jaspery conglomerate identical with the Huronian conglomerate within (east of) its border, while similar material is not yet known to occur outside of it. Prof. T. C. Chamberlin, to whom specimens were submitted, thinks it improbable that they could have come from a point any farther west than the Green Bay movements, and he doubts if they could have come from even that far west, since the fragments of jaspery conglomerate found within the range of that movement are not of the typical kind. The broad valley of East Sugar creek, already noted, borders this moraine on the west. The position of this depression suggests that it may represent the position of the Mississippi at the time the West Point-New London ridge was forming; though this is not yet clearly proven. Upon this point Mr. Leverett writes: "I have not yet been able to get decisive evidence that the Mississippi flowed around the west branches of the West Point-New London ridge. There is no channel across from the Iowa to the Skunk river valleys; and the trough or channel from the Wapsipinicon at Dixon to the Cedar at Moscow may prove to be independent of the Illinois invasion. Were it not for these two intervals there would be a continuous channel from the mouth of the Maquoketa through Goose Lake, Wapsipinnicon, Cedar, Iowa, Skunk river, Big and Little Cedar and East Sugar creek to the Mississippi." The glacial phenomena of the region are extremely complex and difficult of interpretation, but evidence thus far available points to a long interval of erosion between the two

invasions. A study of the rock gorge between Montrose and Keokuk favors this conclusion, though it has not yet afforded grounds for a satisfactory demonstration.

Montrose-Keokuk Gorge.—The average depth of the new channel is 180 feet, of which 135 to 140 feet is in indurated rocks. Keokuk lies in a small amphitheatrelike depression facing southeastward towards the river. This small basin is intersected and drained on the south side by Soap creek. Between the foot of Main street and the mouth of this creek the height of the rock escarpment

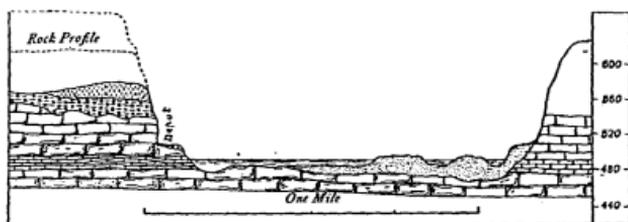


Figure 7. Present Channel of Mississippi River at Keokuk.

does not exceed fifty feet, though both to the north and south it reaches a height of 130 to 140 feet (figure 7). Along the front of this recess and resting upon its rock bed is a deposit whose explanation is not without difficulty. It consists of a bed of loose boulders at the base, overlain by stratified sand, which is succeeded by fine, gray, pebbleless clay or loess. The boulder bed is about twenty feet thick and is composed in large part of coarse, more or less rounded material, chiefly of local origin. Large blocks of limestone but little abraded are occasionally seen. Mingled with the local material are boulders of crystalline rocks, two and three feet in diameter. The interstices between the boulders are filled for the

most part with sand, though pockets of clay are sometimes present. Towards the top the material becomes finer and takes on a stratified arrangement.

At one place the material is cemented with lime, forming a coarse conglomerate. Above this are ten or twelve feet of sand, fine below, becoming coarser above, and arranged in thin layers alternating with similar layers, in which the sand grains are encountered with iron oxide. Upward this bed passes gradually into fine, gray loess, which is fifteen feet thick. The latter includes occasional fragments of chert, a band of which exists about three feet above the base of the deposit. At Warsaw a boulder bed similar to that noted above and three to five feet thick rests upon blue till fifteen to thirty feet in thickness, which is much eroded at the top. Below Nauvoo, rock terraces occur up to an altitude of seventy feet. A rock shelf of the latter height bears a deposit of loess twenty feet in thickness. The loess is of the typical kind and highly fossiliferous. In this case no till intervenes between the loess and the limestone. Between Nauvoo and Hamilton there is very little drift. At several points sand deposits occur below the loess as at Keokuk. No explanation of the Keokuk boulder bed has yet received satisfactory demonstration. The coarseness of the material precludes the belief that it is due to river agencies alone.

A second hypothesis ascribes it to the cutting down of a till sheet. As the current removed the finer material the coarser would settle downward while the infilling of sand may have occurred subsequently.

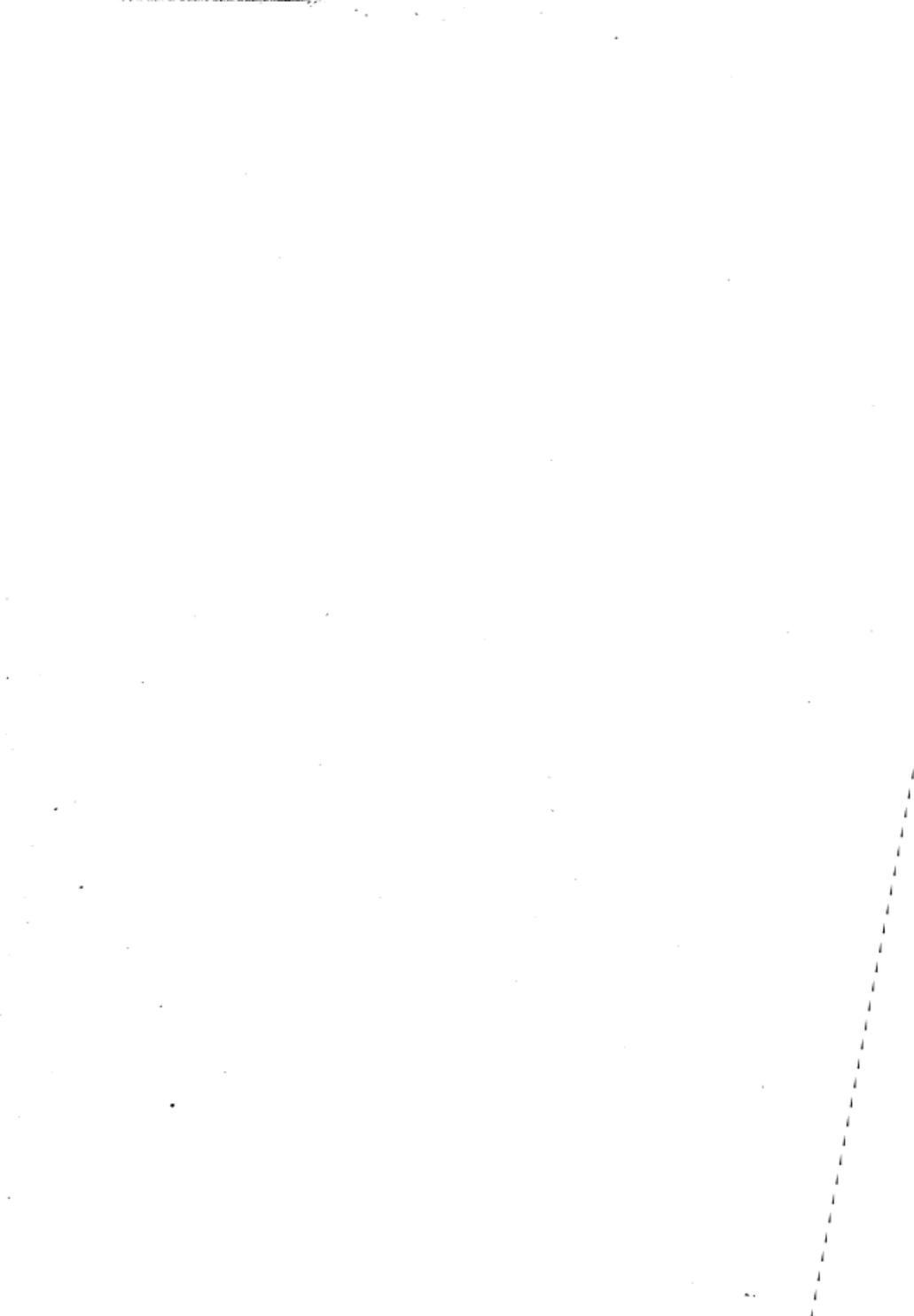
A third view is that the deposit may have been formed in running water at the edge of the ice sheet or within its periphery. If the ice just reached the border of the river its melting would furnish both coarse and fine material, of

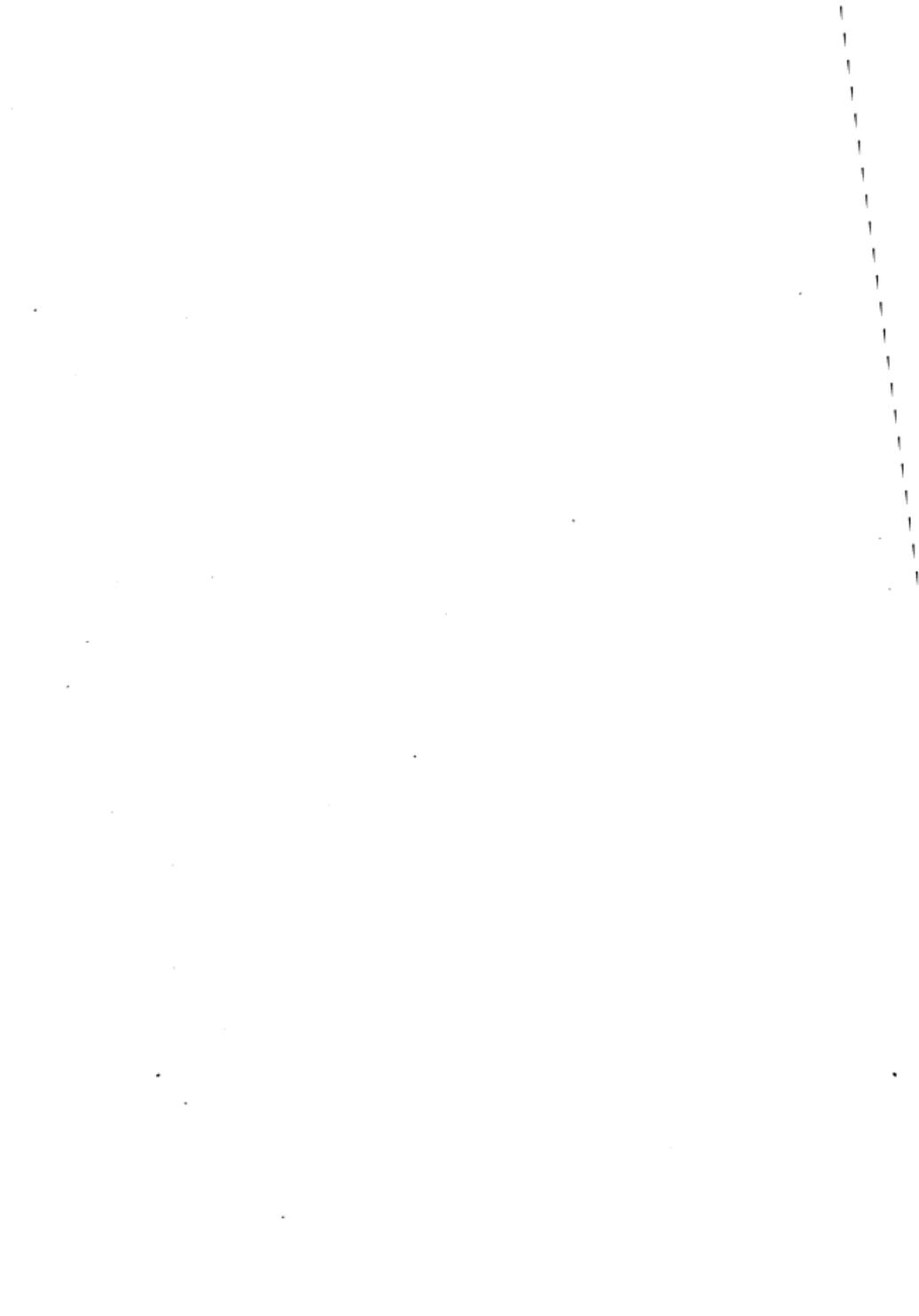
which the former would accumulate at the bottom of the stream while the latter would be carried by the current. In some respects the second suggestion offers the most satisfactory explanation; while in others the third seems to be most satisfactory. The occurrence of the boulder bed at Warsaw capping a deposit of blue till favors the former. If this be the true explanation, then a question arises as to what till sheet it owes its derivation. Its position is eighty feet or more below the level of the rock surface, indicating that erosion to this extent had progressed before its formation. It is evident, therefore, that it does not belong to the drift of the Iowa invasion, unless the depression in which it lies be held to represent preglacial channels tributary to the old valley. If it can be shown that it belongs to the Illinois invasion, then it is evident that a measure of the time intervening between the two invasions appears in the eighty feet of rock excavation, plus an unknown thickness of overlying drift belonging to the earlier till sheet. Evidence apparently confirmatory of this view is supplied by the terrace in the Viele sand plain. These terraces occur up to a height of between fifty and sixty feet above the river, while the bordering bluffs show little if any traces of terrace formations. If the Illinois ice sheet reached across the river between Viele and Keokuk, the drift derived from it would probably wash the terraces formed before its advent, and the present terrace would apparently represent the time since that invasion. The occurrences of the loess at the height of seventy feet above the river resting upon a rock ledge near Nauvoo make it evident that erosion had progressed to this depth previous to the deposition of the loess.

If it can be shown that the loess represents the closing events of the Illinois invasion, then the preceding erosion

period belongs to the interval between the two invasions as above suggested ; and would sustain the view advanced by Mr. Leverett in the study of the Rock river basin* that the two invasions were more widely separated than the whole length of postglacial time. The relations of the loess to the drift, however, are not yet sufficiently clear to justify a final conclusion. The presence of a soil at the base of the former indicates a time interval of considerable importance, but a fuller elucidation of the Pleistocene history of the region must await further study.

*Proc. Am. Acad. Adv. Sci., vol. XLII. 1893.



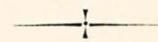


A GEOLOGICAL MAP OF THE IOWA GYPSUM REGION

BY
CHARLES R. KEYES

TOPOGRAPHY BY
E. H. LONSDALE AND F. HESS.

1894.



EXPLANATION

- CRETACEOUS (GYPSUM)
- COAL MEASURES
- LOWER CARBONIFEROUS
- GYPSUM MILL
- GYPSUM QUARRY
- BORING

