OLD CHANNELS OF THE MISSISSIPPI IN SOUTHEASTERN IOWA.

BY FRANK LEVERETT.

One would naturally think that a stream which had been dignified by the title "Father of Waters" would be one that had shown evidence of exceptional stability rather than a bent toward vagrancy. But the Mississippi has been truly a vagrant stream; sometimes it has been forced from its bed by the intrusion of ice in the glacial winter, and sometimes by the accumulations of its own dirt or sediment. It has been shifting not only in the middle portion on the borders of Iowa, but in its lower and its upper portions as well. So many have been its wanderings that only a part of them are as yet understood.

If we turn to a good map of the lower end of the Mississippi valley, a series of branching channels will be found, which distribute the waters quite widely before entering the Gulf. These branching channels or distributaries are traversing a great accumulation of sediment or delta deposit that has been brought down the river and dropped near its mouth. The branchings and shiftings of the stream there, are apparent to every one for they are now in progress. The reason for the shiftings is also readily found in the excessive deposition which has taken place. The main channel of the stream for a long distance above its mouth has built up its bed and banks until it is now flowing on a low ridge which slopes away from the river toward either bluff. It has become necessary to build artificial banks or levees to hold the stream in its course. When these are broken in time of freshets the river turns into the lower land that borders its channel and it becomes difficult to bring it into subjection and hold it in its old course.

This behavior of the Mississippi will serve to show how easily the course of a large stream may be shifted under cer-


Kirtsan Drift
Drittless
JONES
JACKSON
Anamosa
Maquoketa R.
Sabula
Savannah
ILLINOIAN DRIFT
Tirton
LINN
BENTON
Marion
Maquoketa
Wapsipinicon R.
Cedar Rapids
Moose Lake
CLINTON
Mt Vernon
Cedar R.
Iowan Drift
CHANNEL
Clinton
Iowa
CEDAR
Marengo
JOHNSON
IOWA
Tipton
Princeton
Iowa City
Iowa River
West Branch
Durant
SCOTT
LeClaire
River
W Liberty
Moscow
MUSCATINE
Davenport
Rock
TERRACE
Muscatine
WASHINGTON
RIVER
Washington
Columbus Jct
LOUISA
Wapello
Skunk
Winfield
JEFFERSON
HENRY
Mt Pleasant
DES MOINES
New London
Burlington
VAN BUREN
Keosauqua
Denmark
West Point
Ft. Madison
MISSOURI
Montrose
Keokuk
ILLINOIS
DRAINAGE MAP
OF
SOUTHEASTERN
IOWA
by
Frank Leverett.
1901
Scale of Miles
0 5 10 20 30 40

tain conditions. To illustrate the opposite condition, of very prolonged persistence, we would cite the Susquehanna, which crosses the entire Appalachian System of mountains and appears to have maintained its course faithfully through the long period in which the mountains have been in process of uplift. Whether a stream shall persist in its course or be turned adrift depends upon its ability to meet and overcome obstacles and adverse conditions.

Although no mountains of rock have been uplifted in the path of the Mississippi, its valley and much of its drainage basin have more than once been encroached upon by a moving mountain of ice, which became a more complete obstacle to its old course of drainage than the Appalachian Mountains have been to the course of the Susquehanna. There seems also to have been times when the upper portion of the Mississippi valley has had similar conditions to those which are now found in its lower course. As indicated below, its delta-like, silted up portion, at one time reached to the vicinity of St. Paul, Minnesota.

THE EVIDENCE OF SUCCESSIVE GLACIATIONS.

From the earliest days of settlement it has been noted that the central portion of the Mississippi Basin carries a mass of earth and rocks made up of materials, gathered at various points in Canada and the northern United States, which have been transported southward as far as the vicinity of the Ohio and Missouri rivers. This mass of earth and rocks has come to be known as "drift" or "glacial drift," and the transportation has been found to be due to movement of ice from Canada down into the Mississippi Basin. It was at first supposed that the ice floated as bergs and dropped the earthy material and stones which it contained into an inland sea or arm of the Gulf of Mexico. But now it is well established that it moved on the surface of the land in great fields such as the ice-field which still covers much of Greenland, and moves from the interior to the borders of that island. A full discussion of the evidence that it was a field of land ice

and not floating icebergs cannot be given in the space allowed for this paper. But it will perhaps be sufficient to say that the drift has such a definite southern border as could have resulted only from a movement over a land area. If the drift had been deposited in a sea its border should be very indefinite. In addition to the definite border at the south there is found to be a tract in the upper Mississippi region which is driftless, though bordered on all sides by heavy deposits of drift. This tract lies mainly in southwestern Wisconsin and extends slightly into northwestern Illinois, northeastern Iowa and southeastern Minnesota. It has a lower altitude than regions to the north which are heavily covered with drift. This and other evidence goes to show that its driftless character is not due to its being above the limits of the fields of ice, but instead it stood outside their limits.

The character of the drift and other evidence indicate that one field of ice, known as the Keewatin, moved from Keewatin in the central part of Canada southward across Manitoba, Minnesota, Iowa, northern Missouri and the adjacent portions of the Dakotas, Nebraska and Kansas to the vicinity of the Missouri River. It appears also to have encroached a little upon western Illinois. The driftless area, just mentioned, stood on its eastern border. Another field of ice known as the Labrador, moved from the elevated region east and south of Hudson Bay southwestward across the Great Lakes and the states of Michigan, Wisconsin, Indiana and Illinois to southeastern Iowa. The driftless area stood on the western border of this ice-field. There was still another ice-field in the Cordilleran region west of the Rocky Mountains but that does not bear upon the present discussion.

In addition to the division into several ice-fields a study of the drift has shown that it is necessary to recognize successive advances and retreats of each of these ice-fields. Account must also be taken of the order of advance of the different ice-fields. It is found that after an ice-field had

reached its farthest limits and then had melted back far to the north another advance took place which carried the ice-field nearly to its previous limits. This alternation was repeated several times producing a succession similar to that of a series of years in our northern latitudes, the glaciation finding its counterpart in our snowy winter and the succeeding period of freedom from ice in our warm summer season.

As each of these glaciations has produced an easily recognized deposit of drift geologists have been able to interpret the succession of events. They have found it convenient to apply names to the successive glaciations and to the deposits of drift which they made and also to the interglacial stages. The glaciation in which the Keewatin ice-field reached farthest is called the Kansan stage of glaciation, and its deposits the Kansan drift, because in Kansas it reached its extreme limits.

There is evidence in eastern and southern Iowa of the existence of a still earlier sheet of drift, called the Pre-Kansan, which seems to fall short of the limits reached by the Kansan drift. Being completely covered by the later deposits very little is known concerning it, but it probably had considerable influence upon the drainage. We leave it with this brief notice.

The glaciation in which the Labrador ice-field reached its farthest limits is called the Illinoian stage, and its deposits the Illinoian drift, because it terminated in the State of Illinois.

There is evidence that the Keewatin ice-field had reached its farthest limits, deposited the Kansan drift sheet, and withdrawn from the field, long before the Labrador ice-field reached its extreme limits and made the deposit of the Illinoian drift. This is well shown in the region where these drift sheets overlap, in southeastern Iowa. There the surface of the Kansan drift has been concealed beneath the Illinoian drift. It is found by outcrops along streams and by well records, that the Kansan drift had become channelled

by streams, and weathered deeply, and a well defined soil had formed on it, before the Illinoian drift was deposited. The period of weathering and soil formation, has been called the Yarmouth interglacial stage, from the village of Yarmouth in Des Moines county, Iowa, where the occurrence of this buried soil first came to the writer's notice. The soil and attendant weathering is called the Yarmouth soil and weathered zone.

Following the melting away of the Labrador ice-field and uncovering of the Illinoian drift there came another period of erosion by streams and weathering and soil formation, which is known as the Sangamon interglacial stage. This was succeeded by another advance of the ice both on the east and west side of the driftless area. It fell short a little of reaching the limits of the earlier glaciations on the borders of the driftless area and fell far short of reaching so far south as the older drift sheets. That on the west side of the driftless area extended south into eastern Iowa about to Iowa City, its southern limits being in the northern parts of Johnson, Cedar and Scott counties, and its eastern limits in western Dubuque, eastern Jones, and northeastern Clinton counties. It projected down the Wapsipinnicon valley about to the Mississippi, overlapping slightly the Illinoian drift in eastern Clinton and northern Scott counties. This has been named the Iowan stage of glaciation, and the deposits which it made the Iowan drift, from the clear development in eastern Iowa. The immense bowlders of northeastern Iowa were deposited at this stage of glaciation. At the time of the Iowan glaciation there seems to have been an exceptionally low altitude and slack drainage along the Mississippi valley as far up as St. Paul, and this as shown below had an important influence upon the drainage.

Later stages of glaciation affected the headwaters of the Mississippi, but as their influence upon the portion of the valley bordering eastern Iowa is less distinct than that of the stages mentioned space will not be taken to discuss them.

THE OLD DRAINAGE OF THE UPPER MISSISSIPPI.

The portion of the Mississippi drainage basin which lies within the limits of the drift has a drainage system which is very different from the system or systems which drained the same region before the drift was deposited. The Mississippi itself may be occupying sections of two or more independent preglacial valleys. The drift deposits have so greatly concealed the old valleys that it is hardly possible at present to determine what relation the several sections sustained to one another, much less to show the relation to the great systems by which the interior of North America was drained.

Referring to the drainage map of southeastern Iowa (Plate 1) it will be seen that the valley of the Mississippi is very irregular in width. It is narrow near Le Claire, and from Davenport to Muscatine. It is also narrow for a few miles above Keokuk. But elsewhere it has a width of three to six miles. These narrow portions are at places where the river has departed from old lines of drainage while the broad portions denote places where it is utilizing the old valleys.

The portion on the border of northeastern Iowa seems to have turned away from the present valley near Clinton; but it has not been fully determined whether it passed southeastward through the Green River Basin of Illinois to enter the present Illinois Valley near Hennepin, or took a westward course for a few miles through the lower end of the Wapsipinnicon Valley and then turned southwestward past Durant to join the old valley occupied by the present Mississippi below Muscatine. However, the evidence from wells and the great breadth of the Green River Basin seem to favor the southeastward course into the Illinois. This being the case the Mississippi passes from one old drainage system to another in its course between Clinton and Muscatine. But if the southwestward route proves to have been the course of the old drainage the present river departs from it only a few miles and enters a lower section of the same old valley below Muscatine which it occupies above Clinton.

There seems to have been a large drainage line leading southward in preglacial times past West Branch and West Liberty to connect with the broad valley of the Mississippi below Muscatine. The course of the old valley has been determined for only a few miles as that region has now so thick a covering of drift that the course is shown only by means of well borings. Those which are made in the line of the old valley go to depths of over two hundred feet without reaching rock, while those out of the line of the valley usually reach rock at less than one hundred feet.

From Muscatine the old valley is followed by the present Mississippi to the village of Montrose a few miles below Fort Madison. The present river there turns southward across a point of the old east bluff, while the old valley continues southwestward to the mouth of the Des Moines River, where it again receives the present Mississippi. The shaded strip in the map marks the unoccupied part of the old valley in Lee county and serves to show its connections with the occupied portions above and below. It will also be observed that the lower or Des Moines rapids of the Mississippi appear at the place where the river is cutting a new channel east of its old valley.

The comparative size of the old and new channels is shown in a section, Fig. 2 on folded plate, taken from Vol. III of the Iowa Geological Survey. The position of this section is indicated on the map by the line A—B.

CHANGES RESULTING FROM THE KANSAN GLACIATION.

When the ice had melted away at the close of the Kansan stage of glaciation, the drift which it had deposited seems to have so completely filled the old channel in Lee county that the stream found a lower passage along a new course. It is not certain that much of the drainage of the upper Misssissippi took the present course across the lower rapids at that time. Indeed there is a possibility if not a probability that a considerable portion took a course farther east. The most probable course would be that from Clinton

southeastward to the Illinois through the Green River Basin. Owing to disturbances produced by the succeeding stage of glaciation, the Illinoian, it will probably be difficult to map the system of drainage which prevailed on the eastern border of Iowa, in this, the Yarmouth interglacial stage.

CHANGES RESULTING FROM THE ILLINOIAN GLACIATION.

By reference to the map it will be seen that the border of the Illinoian drift lies west of the Mississippi in southeastern Iowa, from Clinton to Lee county, and passes across the lower courses of its main tributaries. The presence of this drift on the west side of the river indicates that the valley from Clinton to Lee county was covered by the ice sheet and would lead us to expect some disturbance of the drainage, if not a complete displacement. An examination of the part of Iowa immediately west of the Illinoian drift border has resulted in the discovery of a complete course of temporary drainage of the Mississippi along or near the border of this sheet of drift. The position of this temporary Mississippi channel is shown on the map. It will be observed that it turns away from the present Mississippi at the mouth of the Maquoketa and passes southward across Clinton county to the Wapsipinnicon, thence southwestward across Scott and the southeast corner of Cedar county to the bend of the Cedar in Muscatine county. It follows the Cedar down to the Iowa and there passes southward on the west side of Columbus City and continues to Winfield in Henry county. Thence it passes westward as a double channel to Skunk River at the corners of Washington, Henry and Jefferson counties. From there it passes southward along the western border of Henry county following Skunk River to Rome, and the lower course of Cedar Creek (reversed) to the vicinity of Salem. It then turns southeastward and joins the present Mississippi about six miles below Fort Madison.

The southern portion of this channel from the Iowa valley at Columbus southward to the junction with the present Mississippi, seems to have been occupied only for a brief

period as it was excavated to the slight depth of but thirty to fifty feet and to a breadth of one to one and one-half miles. At Columbus its bed stands 120 feet above the level of the Iowa River or 710 feet above sea level, and there seems to be scarcely ten feet fall in passing from there to Skunk River. In its course along Skunk River and thence southward to the Mississippi it falls more rapidly, the old bed being about 675 feet at Rome, 657 feet at the line of Henry and Lee counties and 620 feet where it joins the Mississippi below Fort Madison. There is thus a fall of ninety feet in a distance of about seventy-five miles.

The portion of the old channel northeast from the Iowa River has only a short section (between Wapsipinnicon and Cedar rivers) that is up to the level found immediately south of the Iowa River. From this it appears probable that streams continued to flow in this northern part of the channel after the southern part had been abandoned. It will be observed that Cedar River still flows through a part of this channel but it has excavated its bed to a level more than 100 feet below the level at which the waters of the Mississippi drained from it past Columbus. The portion connecting the Maquoketa and Wapsipinnicon rivers has been cut down to a level about fifty feet lower than the old bed at Columbus, showing that it too was a drainage course for a longer period than the portion south from the Iowa River. It seems probable, as indicated below, that the Mississippi itself flowed through this part of the channel at a later time than the Illinoian stage of glaciation. Summing up the above observations, it appears that the southern part of the channel was abandoned by the Mississippi, and also in a large part avoided by other streams, after the ice sheet had melted back far enough to permit drainage through the neighboring portion of the present Mississippi. But the northern part was utilized to some extent by the Mississippi and to a large extent by other streams down to a more recent date, the Cedar still making use of a considerable section of it.

CHANGES ACCOMPANYING OR FOLLOWING THE IOWAN STAGE OF GLACIATION.

At the Iowan stage of glaciation the ice, as already indicated, came down on the Iowa side to the border of the Mississippi near Clinton. It came down on the Illinois side to within a few miles of the Mississippi east of Clinton. The Iowa and Illinois lobes of ice appear to have been coalesced at that time over the headwater portion of the Mississippi above the driftless area.

During the Iowan glaciation a deposit of fine silty material called loess (from a similar deposit on the Rhine in Germany) was laid down between the Iowa and Illinois glacial lobes and in the region to the south. It caps the bluffs of the Mississippi and spreads out to long distances on either side. The precise mode of deposition of this loess is not fully determined. The material was apparently contributed in part by waters escaping from the ice, for it sets in abruptly at the ice border and contains rock constituents similar to the constituents of the fine portion of the glacial drift. This material is likely to have been carried by wind outside the limits reached by the glacial waters. The wind may also have brought in some of the material from the dry western plains. It is found that the thickest and coarsest portion of the deposit follows the main valleys and leads down the Mississippi to the borders of the Gulf. This deposit seems, therefore, to have been connected in some vital way with the great streams of the region. Some geologists have thought that during the deposition of this loess, the Mississippi Valley as far up as St. Paul was in about the condition of the present lower course through Louisiana, and all are agreed that the conditions for drainage were much less favorable than at present.

There seems good evidence that on the borders of Iowa the valley was so filled that the stream flowed near the level of the top of its present bluffs. This is well shown by remnants of the old flood-plain of the stream and of its tributaries

which stand far above the reach of the present waters. On the lower course of Skunk River, for example, the broad terrace which once served as the flood plain of that river opens out into the Mississippi Valley at a level more than 100 feet above the present stream and only forty to sixty feet below the bordering uplands. Let the reader picture the Mississippi flowing at a level 100 feet or more above its present water surface and he will restore a condition which there is good reason to think, prevailed on the borders of Iowa near the close of the Iowan stage of glaciation.

After the loess had been deposited, the country drained by the Mississippi appears to have become more elevated, and with this increase in altitude the streams became more rapid and began to deepen their channels. It was apparently in connection with this deepening of the channels that some of the peculiar drainage features on the borders of eastern Iowa were developed.

Referring to the map it will be seen that several island-like tracts of upland appear on the borders of the Mississippi or in its valley between the mouth of the Maquoketa River and Davenport, around and among which there is a network of channels. The channels are not all cut to a similar depth, a feature which indicates that some of them were abandoned earlier than others. The channel leading from the Maquoketa to the Wapsipinnicon past Goose Lake stands about 660 feet above the sea or nearly 100 feet above the level of the Mississippi at Clinton. The other channels are all cut to a level less than 600 feet above the sea, except the easternmost one on the Illinois side whose bed is a little more than 600 feet. The broad channel which leads from the Mississippi at the mouth of the Wapsipinnicon southeastward to Rock River is cut below 580 feet or to a level less than twenty feet above the present streams. The channel which connects the Rock River and the Mississippi east of Davenport also has a bed below 580 feet. The beds of the unoccupied channels in the vicinity of Clinton stand between 580 and 600 feet,

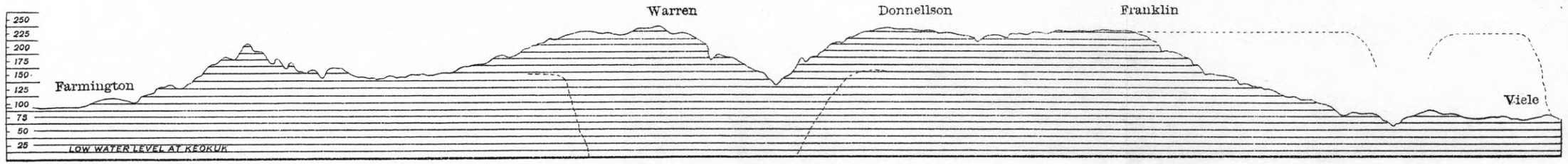

FIGURE 1. PROFILE FROM VIELE TO FARMINGTON.

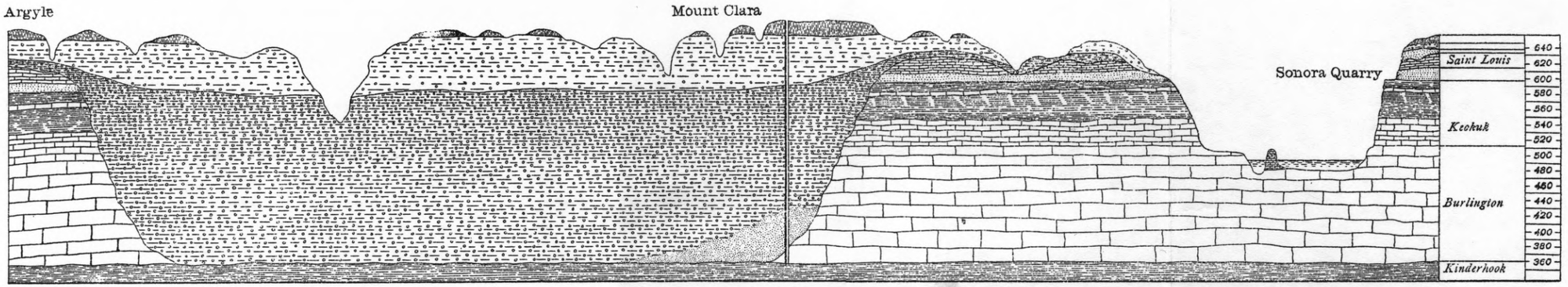

FIGURE 2. SECTION FROM SONORA TO ARGYLE.

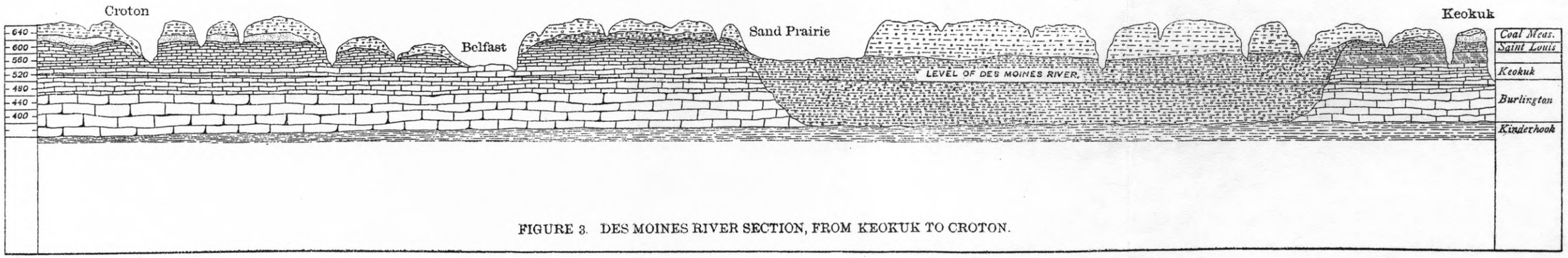

FIGURE 3. DES MOINES RIVER SECTION, FROM KEOKUK TO CROTON.

but the channel which the Mississippi flows in is below 580 feet as far up as the limits of the map.

The development of these islands and channels seems to have proceeded about as follows: At the close of the loess deposition when the stream began to erode that deposit its waters were not confined to a single course but found their way southward along several lines now indicated by the channels shown on the map. Some of these channels happened to be across rock points on the slopes of the preglacial valley that had been covered by the loess, while others were in the line of old valleys. One by one the less direct channels were abandoned until the stream is now established in the shortest of the routes through that district. It has held its course across a rock point just above Clinton at the village of Fulton, Illinois, and also at the Le Claire or upper rapids, though at flood stages it sweeps around both of these rock points as well as across them. The channels across the rock points are much narrower than those in the line of old valleys because the rock presents greater resistance to the corrasion of the stream than is presented by the soft drift material that fills the old lines. It is rather surprising that the advantage of directness of route across these rock points should more than offset the disadvantages in the resistance to erosion, but the course taken by the stream proves this to be the case. It is scarcely probable that the stream will in the future turn from its course across these rock points to the less direct courses around them. Indeed in this upper part of the valley the "Father of Waters" seems to have settled down to a steady course, except at flood seasons, when it becomes too full to stay within bounds.

A list of publications bearing upon this portion of the Mississippi Valley is appended.

The Mississippi Valley. By J. W. Foster. Chicago, 1869.

Bridging the Mississippi River. By G. K. Warren. Report of U. S. Army Engineers for 1878-79, Vol. 4, Part 2.

Water Power on the Mississippi and its Tributaries. By J. L. Greenleaf. Tenth Census of the United States, Vol 17, 1880.

Drainage Systems of Iowa. By C. A. White. Geology of Iowa, Vol. 1, 1870, pp. 35-70.

Physical Features of Rock Island County, Illinois. By A. H. Worthen and James Shaw. Geology of Illinois, Vol. 5, 1873, pp. 217-226. See also brief references to the rapids on the Mississippi by Worthen, Geology of Iowa, Hall and Whitney Survey, 1858, and Geology of Illinois, Vol. 1, 1866.

The Driftless Area of the Mississippi. By T. C. Chamberlin and R. D. Salisbury. Sixth Annual Report U. S. Geological Survey, 1884-85, pp. 199-322. This paper refers to many earlier publications that touch upon the driftless area.

The Pleistocene History of Northeastern Iowa, by W J McGee. Eleventh Annual Report U. S. Geological Survey, 1889-90, pp. 189-577. Earlier papers by McGee that bear upon the history of northeastern Iowa are embodied in this monograph.

The Illinois Glacial Lobe, by Frank Leverett. Monograph XXXVIII, U. S. Geological Survey, 1899. See especially pages 19-70, 89-97, 119-184, 460-480.

The topography and drainage of the following counties in eastern Iowa are briefly discussed in the reports of the present Iowa Geological Survey as follows:

In Vol. III, 1893, Des Moines County and Lee County, by C. R. Keyes. Buried River Channels in Southeastern Iowa, by C. H. Gordon.

In Vol. IV, 1894, Allamakee County, by Samuel Calvin; Linn County, by W. H. Norton; Van Buren County, by C. H. Gordon, and Keokuk County, by H. F. Bain.

In Vol. V, 1895, Jones County, by Samuel Calvin, and Washington County, by H. F. Bain.

Volume VI, 1896, contains an elaborate paper by W. H. Norton on the artesian wells of Iowa.

In Vol. VII, 1896, Johnson County, by Samuel Calvin.

In Vol. VIII, 1897, there is a preliminary outline map of the drift sheets of Iowa by H. F. Bain, and reports on Delaware and Buchanan counties, by Samuel Calvin.

In Vol. IX, 1898, Muscatine County, by J. A. Udden; Scott County, by W. H. Norton. Norton's report contains maps illustrating the drainage changes in the vicinity of the upper rapids (Plates IX, X, XI).

Volume X, 1899, contains a report on Dubuque County, by Samuel Calvin and H. F. Bain, with a topographic map of the county by the U. S. Geological Survey.

Topographic maps of a large part of eastern Iowa have been made by the U. S. Geological Survey, Washington, D. C.

In the Proceedings of the Iowa Academy of Science there are short papers by Bain, Beyer, Calvin, Fultz, Leverett, Shimek and Todd, which discuss special features of the drift, the loess, and the drainage of eastern Iowa.

There are also brief discussions of the glacial deposits by McGee and other geologists published in the Transactions of the Iowa Horticultural Society.

In addition to the monographs and papers which have appeared in the above mentioned official reports a considerable number of papers are found in geological magazines, but

these are largely by authors who have published more fully in the official reports. Mention should be made of a paper by Oscar Hershey on the Physiographic Development of the Upper Mississippi Valley, American Geologist, Vol. 20, 1897, pp. 246-268.

THE DES MOINES STEAMER.—Our enterprising friends at Iowaville are busily engaged in the construction of a steamer building at that place for the Des Moines river trade. The intention we understand is to have her completed and ready for next spring's business. We like the idea vastly. The first stroke of her paddles on the Des Moines will commemorate the beginning of a new era in every branch of industry in this great valley. When our friends launch their boat we should like to be there to see.—*The Western American, Keosauqua, Iowa, June 19, 1852.*

WE UNDERSTAND that a noble old buck ventured into our town early this morning, and boldly sought provisions in the yards of some of our townspeople. He was soon routed, however, by the dogs, and away he went towards the woods, passing in close proximity to several houses, and skipping over fences as if they were mere straws. The depth and duration of the snow this winter, have deprived the deer of their usual sources of food, and caused them much suffering from hunger. Venison is plenty in our market, and fine carcasses can be bought at from 3 to 4 cents per pound.—*Quasqueton (Iowa) Guardian, Jan. 31, 1857.*