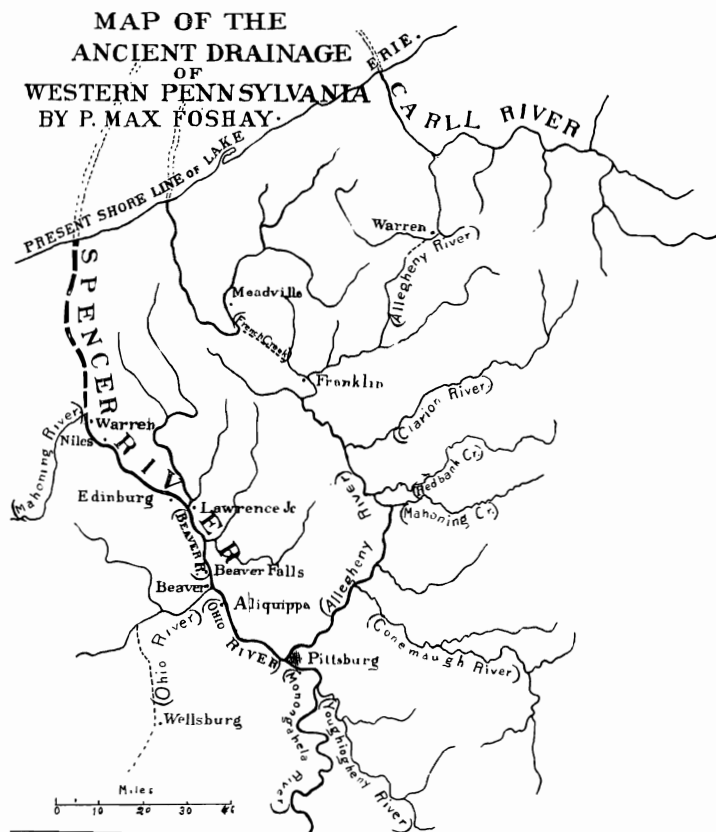


ART. LI.—*Preglacial Drainage and Recent Geological History of Western Pennsylvania*; by P. MAX FOSHAY, M.S., F.G.S.A.

THE investigation into the preglacial drainage of Western Pennsylvania, of which this paper is a partial record, was primarily incited by a suggestion thrown out by Professor J. W. Spencer, in a paper read before the Am. Phil. Soc., March 18, 1881. Professor Spencer there advanced the hypothesis that the Beaver River, with part of the Ohio, had in preglacial times constituted a stream which flowed up the modern Mahoning through its now buried channel into the Erigan River (Spencer) which then traversed the basin of Lake Erie. This stream, now become parts of several modern rivers, I have named Spencer River in honor of the investigator who first suggested its existence and to whom is due so large a proportion of our present knowledge of the preglacial drainage of the region of the Great Lakes. Spencer River drained an area nearly co-extensive with that of the Pennsylvania portion of the modern Ohio with its tributaries, including the basin of the Monongahela and part of that of the Allegheny, thus

carrying off the rainfall of almost all Western Pennsylvania and Eastern Ohio.

The preglacial drainage of Northwestern Pennsylvania and Western New York was long since thoroughly worked out by Professor John F. Carll, who was the pioneer in this field. In the course of his survey in Northwestern Pennsylvania he collected proof* of the existence of at least two northwardly



flowing preglacial streams which drained the northern part of the present Allegheny basin and debouched, like Spencer River, into the Eriean River. The Allegheny River, as we now know it, did not then exist but was formed after the glacial episode, during which time the mouths of the ancient northwardly flowing streams had been blocked up. This blocking up of the ancient drainage forced the post-glacial

* Report III, Second Geological Survey of Pennsylvania, pp. 330-366. John F. Carll, Harrisburg. 1880.

ivers to overflow to the south and cut down their divides. They united to form the modern Allegheny River and thus we have the phenomenon of reversed drainage in the upper Allegheny region. The story of the Beaver valley is to be told in much the same words, but Professor Carll—not having examined the region—did not see as clearly as Professor Spencer the former drainage of this part of the State. He says,* “I strongly suspect that Big Beaver River is a glacial enlargement of a small ancient stream formed in the same manner as those found in the summit basins and that anterior to the Ice Age the Shenango and other headwater streams of the Beaver, including the Connoquenessing, delivered northwardly through the Mahoning and Grand Rivers into Lake Erie basin. . . .” If he had placed the ancient divide, cut through during the Glacial Epoch, in the present Ohio valley somewhere between the mouth of the Little Beaver and Wellsburg, W. Va., instead of placing it in the Beaver valley, he would have been correct, as will be seen below.

The evidence that Spencer River, whose bed is now buried beneath many feet of drift materials, once flowed northwardly is to be found in a very complete series of measurements of the depth of the drift filling taken from the records of oil and gas wells drilled in the valleys during recent years. In the table below I give only maximum depths at not too frequent intervals but it must be understood that there is hardly a mile of the distance covered in which there are not one or more records showing the presence of the old channel.

	Dist. from Pittsburgh.	Place.	Low Water. A. T.	Depth of Filling.	Old Floor. A. T.
1.	0	Pittsburg.	699 ft.	44 ft. †	655 ft.
2.	10	Coraopolis.	?	50 ft.	?
3.	19	Aliquippa.	677 ft.	60 ft.	617 ft.
4.	25.2	Beaver.	670 ft.	+ 60 ft. ‡	— 610 ft.
5.	29.8	Beaver Falls.	700 ft.	+ 100 ft. §	— 600 ft.
6.	46.8	Lawrence Junc.	760 ft.	+ 150 ft.	— 610 ft.
7.	51.4	Edenburg.	780 ft.	200 ft. ¶	580 ft.

The figures in the fifth column of the table it will be seen demonstrate a progressive deepening of the drift filling as we go northward and when reduced to tide-level prove that the old floor at present dips slightly to the north.

* Report III, Sec. Geol. Survey Pa., p. 392—footnote.

† An. Rep. Pa. Survey 1886, Pt. II, p. 730. Jones & Laughlin, Nos. 1 and 2.

‡ Rep. Q. Pa. Survey, I. C. White, 1878, p. 14.

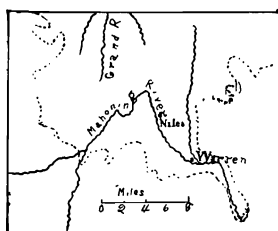
§ Rep. Q. Pa. Survey, I. C. White, 1878, p. 15.

|| Rep. Q. Pa. Survey, I. C. White, 1878, p. 16, quoted from Dr. J. S. Newberry in *Geology of Ohio*.

¶ Rep. QQ, Pa. Survey, I. C. White, 1879, pp. 19, 184, 202.

The elevation of No. 6 at the confluence of the Mahoning and Shenango does not constitute an exception as the well from which the record was taken went 150 feet through drift and not having reached rock was abandoned. There is thus a total fall of 75 feet in the 51.4 miles covered by the table, reaching down to an elevation of only eight feet above the present surface of Lake Erie.

The fact of a post-glacial elevation of the northern part of the continent is now well established. The differential uplift shown in the younger beaches about the overlapping ends of Lake Erie and Lake Ontario is about two feet per mile.* Mr. McGee's survey of the rise of the older Columbian drift formation would make the Pleistocene and recent deformation amount to about three feet per mile. Adding this dip to the present profile of the floor of Spencer River we obtain an abundant northward fall of the old bed. Well records at Niles, O., show the presence of the old channel at that point. A few miles north of this point the country falls away towards Lake Erie and a number of country wells give depths of drift filling almost sufficient to *prove* the fall of the old bed far into Grand River basin. In addition to this the Grand River of Ohio, along with the other Ohio Rivers, was shown by Dr. Newberry's survey to have a buried channel amply deep to be a continuation of Spencer River.†



The accompanying figure (fig. 1) shows in dotted line the outcrop of the hard Conglomerate Series as drawn on Orton's geological map of Ohio. The remarkable embayment in this outcrop, heading at Youngstown, O., furnishes strong presumptive evidence of the existence of a reversed drainage in this locality. The Mahoning River after coming into the

bay at its side and flowing some miles in the normal direction makes a sudden bend and flows at right angles to its former course *towards* the head of the embayment. The great amount and peculiar form of erosion which the Conglomerate Series has suffered in the formation of this embayment could only have been accomplished by a stream flowing northwardly through the bay in a now deeply buried channel, i. e. Spencer River.

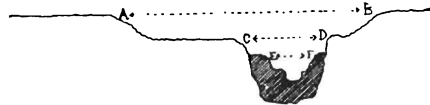
Even disregarding the northward Pleistocene elevation the only other possible outlet for Spencer River is through the

* The Iroquois Beach; by J. W. Spencer. Trans. Roy. Soc. Can., 1889, p. 128.

† Geology of Ohio, vol. ii, p. 199.

valley now occupied by the Ohio below its point of meeting with the Beaver. That this could not have been the outlet is proved by the following facts:—at Smith's Ferry, on the Pennsylvania Ohio State line, two favorably situated measurements give a maximum depth of drift filling of 30 feet* and at Steubenville, O., the channel could not possibly have been deep enough to drain Spencer River.† The conclusion is thus made imperative, independent of the northward crust movements, that this area must have drained northwardly into the Erie basin. This ancient basin would then include the areas now drained by the Lower Allegheny, Clarion, Redbank, Mahoning, Conemaugh, Youghiogheny, Cheat, Monongahela and Little Beaver Rivers. The Monongahela and Allegheny are both known to have buried valleys, the former‡ as far as its junction with the Youghiogheny and the latter§ to somewhere north of Parker.

The topography of the Beaver Valley is shown in fig. 2, which is an ideal cross-section. It consists first of an old base-level plain (AB) bounded on either side by slopes rising slowly to the level of the table-land which is the basis of the topography of the region; of a rock gorge (CD) extending from 300 to 350 feet below the level of the plain, which is completely filled with drift for the lower 100 feet and partially for the next 125 feet; and of an inner gorge (EF) in the drift whose excavation by the modern river gave us the drift terrace system.



AB, old base-level plain.

CD, outer or rock gorge.

EF, inner or drift gorge.

The shaded portion represents the drift filling of the old rock gorge with its terraces of erosion.

The old base-level plain has more frequently been called the "fourth terrace," though it was known to have no connection with the other terraces. It is a mile or more in width and is covered in all places south of the terminal moraine by a deposit consisting of white or yellowish clay, of variable thickness up to ten feet, which in places contains intermingled pebbles of northern drift, and frequently has sand or gravel above or below it, or both. The maximum observed thickness of the whole deposit is twenty feet. This clay deposit is very constant wherever the old base-level plain—a mere bench often—is found. The plain has in all places, south of the moraine, a rocky scarp on its river side and is always (in the Ohio and

* Report QQ, I. C. White, Sec. Geol. Survey Pa., 1879, p. 16.

† Report QQ, I. C. White, Sec. Geol. Survey Pa., 1879, p. 17.

‡ Report K, Sec. Geol. Survey Pa., J. J. Stevenson, 1876, p. 20.

§ Report V, Sec. Geol. Survey Pa., H. M. Chance, 1879, ix, x and 19.

lower Beaver valleys) at a higher elevation than any of the Pleistocene terraces. It is most marked in the Beaver valley on account of its being formed for the most part from the more resisting rocks of the Conglomerate Series, but it is easily made out in the Ohio valley from Pittsburg to Beaver and also far up the Allegheny and Monongahela valleys. South of Beaver, on the Ohio, it has not been observed. Ascending the Beaver the plain falls from 915 feet A. T. at Beaver Falls to 890 feet A. T. at the mouth of the Connoquenessing—a distance of ten miles. There can be no doubt that this was once the bed of an ancient river at a time long anterior to the First Glacial epoch, and, from its northward fall, the stream must have flowed in that direction. The plain thus indicates a long epoch, when the preglacial drainage had not yet cut the deep cañons which marked the topography of the later Tertiary period. The clayey deposit over the plain belongs to a Pleistocene epoch antedating that during which the terminal moraine was formed as it seems to pass beneath the moraine with its kames at the point of contact. It seems to record an episode when the continent was lower than now. Possibly it may be contemporaneous with McGee's Columbia formation(?)

Following the period of the base-level plain came long ages of high continental elevation—higher than the present—during which all the streams of Western Pennsylvania cut channels far below their present beds. This epoch (Pliocene?) was either one of slight precipitation or of comparatively short duration as none of the tributary streams reached a base-level of erosion but were flowing through V-shaped cañons of rather rapid fall when the period of the terminal moraine with its subsidence filled all these old channels with drift to nearly the level of the old base-level plain. During all the foregoing time Spencer River had drained the region in question, its waters delivering into the Erie basin. After the deposit of the drift in the valleys of Pennsylvania a divide was formed across the old channel of Spencer River at Orwell, O., and the drainage of the region became for the most part reversed—the waters now finding their way into the lower Ohio and thence to the Mississippi.

The northern elevation of the continent so thoroughly worked out by Gilbert and Spencer in New York and Ontario occurred at this same time and so confirmed the region in its drainage to the south. The modern rivers now began eroding their beds of drift and are still at work. That this process has gone on uninterrupted for a long period of time is shown by the fact that many of the tributaries of the Beaver and Ohio have flat flood plains, underlaid by the buried channels of the former drainage level, extending two miles or more back from

the river. There is every indication however of a very modern elevation ($40 \pm$ feet) of the region, accompanied by a rapid deepening of the main channels of drainage, in the fact that these tributaries have but recently begun eroding their beds near their mouths. This process has in no case extended more than one-fourth mile. In thus eroding their beds the streams in many cases have deepened their channels in lines which do not correspond with their buried channels but lie to one side or the other; and so we find them running over ledges of rock near their mouths, which has led many observers to the conclusion that the tributaries could not flow over buried channels. In all cases that I have examined, however, I have found strong evidence of the existence of such channels—of which there is positive proof in many wells and excavations.

Beaver Falls, Pa., August 9, 1890.