Some Features of Delta Formation.

By Charles R. Dryer.

In August and September, 1902, the writer spent some weeks among the western Finger lakes in Livingston and Ontario counties, New York. Along the shores of Hemlock Lake his attention was attracted by many recently formed deltas which seemed to present unusual features. Each delta was a semi-circular pile of fine shale shingle symmetrically arranged around the mouth of a little gully formed by a wet weather stream. The level top stood about two feet above the lake surface and was bounded by a bank of shale which sloped downward about three feet in six to a mud line under water. The wash of waves had cut at the top of the slope a vertical cliff six inches high. The land side was bounded by a very steep bank of stratified shale, a portion of the general lake shore, which is almost everywhere precipitous. From the mouth of the gully a groove a foot wide and six inches deep extended straight out half way or more across the top of the delta, but in no case reached the water's edge. Along the sides of the groove lay sticks of wood and fragments of shale of relatively large size. One medium sized delta measured thirty-one feet by twenty-six in diameter. No camera was at hand, but sketches were made from which a rough model was constructed and photographed. (Fig. 1.)

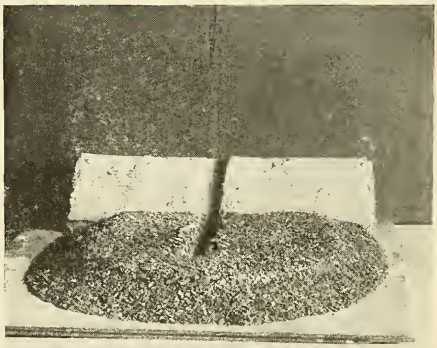


Fig. 1. Model of Torrential Delta in Shale Gravel.

The interpretation of the phenomena seemed plain. These deltas were built during an exceptionally violent storm which filled the gully with a rushing torrent and raised the level of the lake. The force of the stream was abruptly checked at lake level and its load was deposited in the form of a fan-like delta. Toward the last of the storm the stream striking the

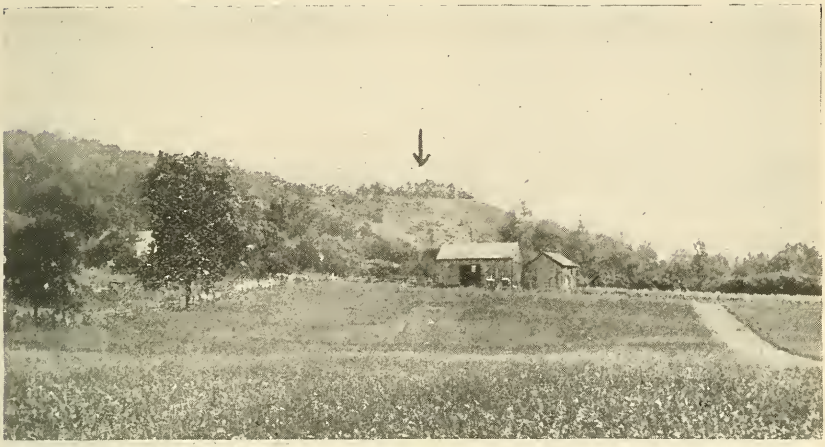
flat top of the delta dug out the groove for a few feet, but was deflected upward and spread out into a thin sheet before reaching the edge. This interpretation was confirmed by the records of rainfall and lake level kept by the Rochester water works at the foot of the lake, which is the source of public supply for that city. These records are as follows:

Date.	*Hours.*	*Rainfall.*	*Lake Level Above Datum.*
July 5	12:30–7:00 p. m.	.921 in.	1.736 ft.
" 6	In the night.	2.349 "	2.926 "
" 7	10:00–11:00 p. m.	.546 "	3.106 "
" 8	.....	.....	3.126 "
" 18	8:00–11:00 a. m.	.101 "	2.176 "
" 19	In the night.	1.397 "	2.296 "
.....	2:00–6:00 p. m.	.607 "	.....
" 20	In the night.	.864 "	2.546 "
" 22	.....	.....	3.186 "

These deltas were begun during the heavy rains of July 5-7, when 3.816 inches of rain fell and the lake rose 1.39 feet, most of the work being done in the night of July 6, when 2.35 inches of rain fell. They were completed July 18-20, when 2.97 inches of rain fell and the lake rose 1.01 feet. These miniature torrential deltas furnish suggestions for the interpretation of similar but larger features which mark the shore lines of the temporary glacial lakes formerly occupying the Finger lake valleys.

A similar flat-topped, steep-sided feature caught the writer's eye on the east side of Honeoye Lake. Projecting from the steep hillside like a bracket it rose 200 feet above the lake, suggesting by its bold and symmetrical outlines an artificial origin similar to that of the dump pile of a mine (Fig. 2). It proved to be a torrential delta built at the mouth of Briggs gull. Its finely curved front slope, about 150 high, is as steep as the material will lie. Its flat top is traversed by a channel twenty feet wide and three feet deep which extends to the edge and is continued by a similar groove in the steep face. The southern side cut away by the main stream shows characteristic foreset beds of sand containing large fragments of shale near the top. Briggs gull now drains a basin of about six square miles. A heavy rain with rapid melting of ice or a sudden diversion of drainage by the breaking of an ice dam in glacial times may have enabled the stream to build this delta in a few days or weeks. Briggs delta helps to account for the anomalous distribution of glacial lake deltas. Similar features are numerous in the Finger lake valleys. Not their presence but their absence from the former mouths of many streams seems

the chief problem. Why do not deltas occur on all of the hundreds of streams that score the valley sides? Why did one stream a mile or two long build a delta a few rods in area while a much longer stream near by



A.

B.

Fig. 2. Briggs Delta. A. From below. B. From above.

built none? The answer seems to be that such features have no prolonged history, but owe their existence to a single local and brief accident of drainage which did not affect neighboring streams.

The largest delta of this class observed in the region, at Bristol Springs on the west side of the Canandaigua lake valley, was built in the Naples-Middlesex glacial lake at one nearly static or slowly subsiding level. The top, about one-half by one-quarter of a mile in area, is smooth and gently sloping forward from the 1,200 to the 1,100-foot level. The surface material is very coarse, containing rounded cobbles up to six inches in diameter, often with little admixture of finer sediment. This delta was built by a stream from the Bristol valley, which during the process must have drained a loaded ice lobe and not a lake.

Such simple, flat-topped, steep-sided deltas, resembling the bastion of a fort or an abutment prepared by a daring engineer from which to spring

Fig. 3. Naples Delta. Two Upper Levels. A kettlehole in the woods.

the arch of a bridge, are formed rapidly by strong or torrential streams and are composed of relatively coarse materials. From their striking and characteristic form and position they may be called *bracket deltas.*

Garlinghouse delta, a few miles south of Naples, does not project like a bastion from the face of the valley wall but fills a niche a mile deep and half a mile wide, the walls of which rise sharply 500 feet above its surface. The niche now receives two or three insignificant brooks, but one of them comes from a gap in the wall which opens northward to the upper Honeoye valley. This gap probably once transmitted a strong stream from the ice front but a few miles distant. This delta may be the only one of its kind, and if so, belongs in a class by itself—that of *niche deltas.*

Compound deltas built at several different levels are numerous in the Finger lake region. Coy Glen delta near Ithaca, a fine specimen of the type, rises from the Cayuga valley to a height of 700 feet like a giant staircase of seven steep, convex risers and as many flat treads, each of which has been evenly bisected by the stream. Such deltas are formed in waters the level of which is alternately standing and falling, the upper step being the oldest. They may be distinguished as *step deltas.*

The delta above Naples rises 400 feet and has a basal periphery of more than two miles. (Fig. 3). Seven levels are distinguishable, of which the upper three are the most conspicuous. The greater part of its mass

Fig. 4. Pitted Surface of Morainal Delta.

was brought by a stream which flowed out of the Honeoye valley from the west and was the outlet of the glacial Honeoye Lake. Streams which flow out of lakes cannot, as a rule, have sufficient load to build large deltas, and the question at once arises, how could the outlet of a lake build one in this case? Its construction was not a matter of a brief period but continued through the whole life history of the Naples-Middlesex glacial lake, into which the stream emptied. The presence of this delta is evidence, so far as it goes, that during that period no lake existed in the Honeoye valley. The area of the land which could have been drained to this delta is insignificant, and we are apparently forced to the conclusion that it was built by drainage from a drift-loaded ice mass. This inference is sustained

by the occurrence upon the highest level of a sharp kettle hole 300 feet in diameter and 25 feet deep, marking the place where a detached ice block stranded and melted.

The occurrence of kettle holes in deltas is not uncommon.[1] A remarkable case of this kind has been described by the writer where an area of ten acres of delta surface is thickly pitted with small kettles.[2] (Fig. 4.) This delta is the joint product of a land stream and a valley glacier which contributed ice blocks and an undetermined portion of the permanent material. There are probably many intermediate forms between such a *morainal delta* and one due wholly to stream work.

Fig. 5. Outer Face of Morainal Delta. Fan in front of notch.

When lake waters are withdrawn the bisection of a delta may result in the formation of an alluvial fan in front of it. This gives a characteristic combination of *notched delta and fan.* (Fig. 5). The fan of Mill Creek at the foot of Honeoye Lake is a mile in diameter, and is responsible for the existence of the lake, to which it acts as a dam. The fan of Canadice outlet bears a similar relation to Hemlock Lake, which, however, is too deep to owe its existence wholly to that cause.

Deltas occasionally take the form of long, narrow ridges upon one or both sides of a stream, resembling the natural levees in "the goosefoot"

[1] Fairchild, Journal of Geology, Vol. 6, p. 589.
[2] Bulletin Geological Society of America, Vol. 15, p. 457.

of the Mississippi. Normally the point where a tributary valley joins a larger one is marked by a notch in the wall of the latter, but in some cases a bisected spur appears instead. The delta of Canadice outlet, mentioned above, furnishes a good example. A delta at Lake Warren level, near East Bloomfield, what is left of it, has the form of a single narrow tongue more than a half mile long. Such lateral deposits of a stream may be called *levee deltas.*

Hanging deltas have been the chief guides to geologists in mapping the outline of temporary glacial lakes, but they are worthy of more careful study as simple and well displayed specimens of constructional shore forms.[3]

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[3] Nearly all the features mentioned in this paper may be found upon the Wayland, Naples, Honeoye and Canandaigua sheets of the Topographic Map of United States.