CHAPTER 2 - The Geology of Enfield By William A. Bassett

The Landscape

The landscape that surrounds Enfield is extraordinary. From a distance or as one might observe it from an airplane approaching Tompkins County Airport, the area seems to be a gently rolling countryside consisting of rounded hills and broad valleys. The rolling hills and broad valleys are deceptive. Tucked away along the sides of the valleys are gorges with steep sides and tall waterfalls, some of the most spectacular examples of rugged topography to be found anywhere. A gently sloping hillside with a pine forest may give way abruptly to a precipice that drops hundreds of feet to a roaring creek below.

What is there about the geologic history of the area that led to such a contrast and to such spectacular scenery? The origin of these features, both the rolling countryside and the rugged gorges, can be traced to the continental glacier that covered the land until about ten thousand years ago.

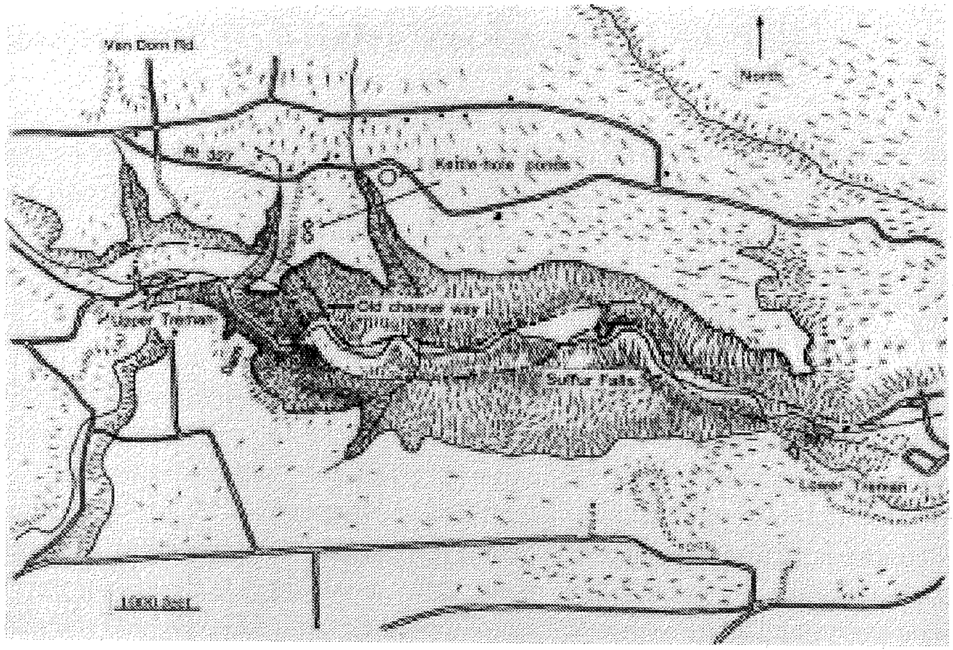
Imagine for a moment what it must have been like ten thousand years ago. The valleys were filled with rivers of ice hundreds of feet deep that flowed at a snail's pace carrying along rock debris ranging from sand grains to boulders. A glacier is one of the most awesome agents of erosion. It scours the land surfaces, taking everything along with it. Valleys that once had been irregular and wandering with V-shaped cross sections were left as great round-bottomed U-shaped valleys. The spurs and bends along the sides were simply wiped away and the floors of the valleys were dramatically deepened. However, because the ice flowed southward, it was only the north-south valleys that were scoured this way. The east-west valleys escaped this kind of erosion, in fact, they tended to be the recipients of the debris, in many cases being filled to the brim with boulders, gravels, and sands known as glacial drift.

Try to visualize what it must have been like after the ice melted. East and west flowing streams were now filled with glacial drift and left high on the sides of the deepened north-south valleys. As the glacial drift was washed out of the east-west hanging valleys, the water in some cases had to drop great heights to the floors of the new valleys. This formed high waterfalls that began to work their way back from the broad valleys into the soft sedimentary rocks of the area. As they eroded back, they formed the deep gorges we see today. If the rock layer over which the water was falling was more resistant than the layers beneath it, the flowing water washed away the softer rocks beneath and continued to fall precipitously over the lip of the resistant layer. This configuration persisted as the falls worked farther and farther up stream to the east or to the west. As a result, many of the present day waterfalls, such as Taughannock, can be visited only after a walk up a narrow, steep-sided gorge to the point where the falling water is presently eroding the rocks.

More about the history of the gorges and other geologic features can be found in a fascinating book: The Finger Lakes Region, Its Origin and Nature by O.D. vonEngeln. This book has been a favorite of the residents of the area since it was first published by the Cornell University Press in 1961. It has just been reprinted as a paperback with a fine photograph (taken by Arthur Bloom) of Enfield Glen on its cover.

Enfield Glen

While the description given above is important to understanding the formation of the area gorges, it only partly explains the unusually narrow and steep sided upper end of Enfield Glen where Lucifer Falls is found. Here another process was at work. As mentioned above, glaciers affect the landscape not only by scouring but also by filling. Every time the glacier scoured away some feature along a valley or hillside, it also had to find a place to deposit the material it picked up. These deposits take a variety of 4 forms; the rounded hills known as drumlins that occur in profusion between Rochester and Syracuse, the hills known as moraines along the north shore of Long Island where the glacier ceased its southward

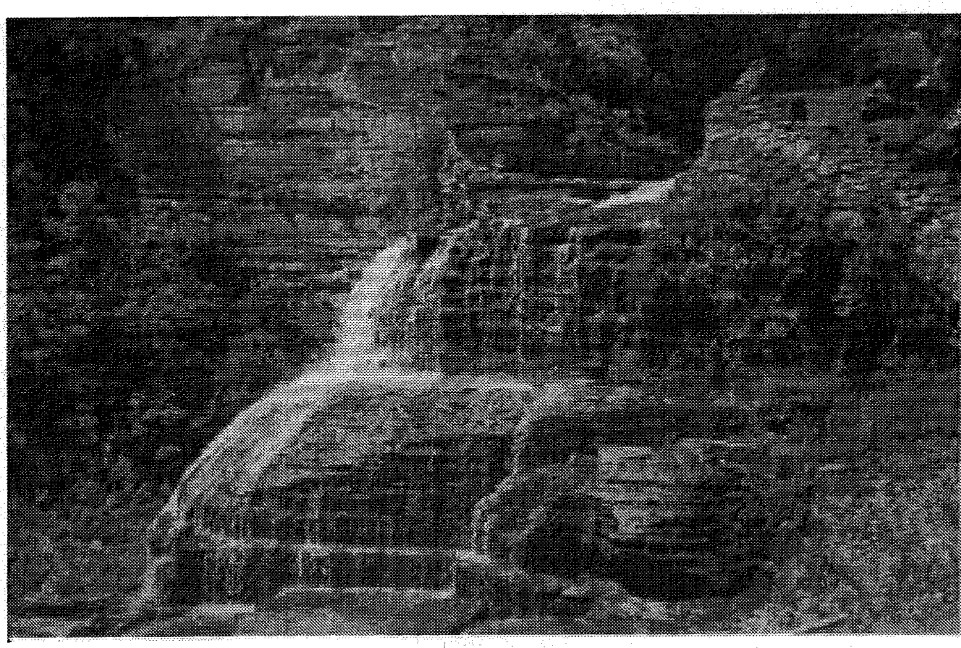


4. Figure 1.

push, the erratic boulders that are found sitting in fields, the piles of debris along the sides of the north-south valleys. It was also common for the glacier to fill depressions in the land surfaces that it rode over. Much of this drift is known as till which is characterized by being very poorly sorted; big boulders are mixed in right along with gravel, sand, and silt.

It should come as no surprise, then, that the east-west valleys that the glacier couldn't get down into and scour provided receptacles for the drift instead. This is apparently what happened at Enfield Glen. When the glacier receded, the old Enfield Glen valley was filled to the top with till. Once the ice was gone and the melted water ran down the old valley, it ran over the top of the glacial till in the valley and eroded its way down through it. However, there were two places in Enfield Glen where the gravel was piled so high that it diverted the new stream so that it flowed over solid rock rather than the gravel fill. When this happened, the new stream eroded its way down through rock and left the gravel in place in the original valley looking very much like a dam. Between the upper parking lot and the footbridge below Lucifer Falls are the remnants of that valley fill "dam". Just after the glacier receded, you could have walked from one side of the valley to the other on its broad, smooth, level top. For the next 10,000 years the flowing water eroded its way down into the bedrock making a narrow slot with very steep sides. It is this narrow, steep sided slot that makes the spectacular gorge at the upper end of Enfield Glen. The same type of diversion occurred farther down stream to produce the narrow portion of the glen where Sulfur falls is found.

Perhaps the most extraordinary part of this story is that the "dam" is still there. Figure 1 shows the broad, smooth, and nearly level top. Although it now has large trees growing on it, the observant hiker should have no trouble getting a clear picture of this remarkable feature. Most amazing, however, is that you can still walk along its crest from one side of the old valley to the other. The most impressive way to do this is to park at the entrance to a small park road along Route 327 three tenths of a mile east of the intersection of VanDorn Road. The park road starts at a gate just under a large yellow sign warning of a curve in the highway. Be careful not to block the entrance. The park road that starts there goes right along the top of the "dam" to the far side of the old valley. That is, as you walk along the top of the "dam", you are on gravel but arrive back in bedrock just before coming to the very steep north wall of the present gorge. Of course the top of the "dam" can be reached as well by hiking up the Red Pine Trail



5. Figure 2.

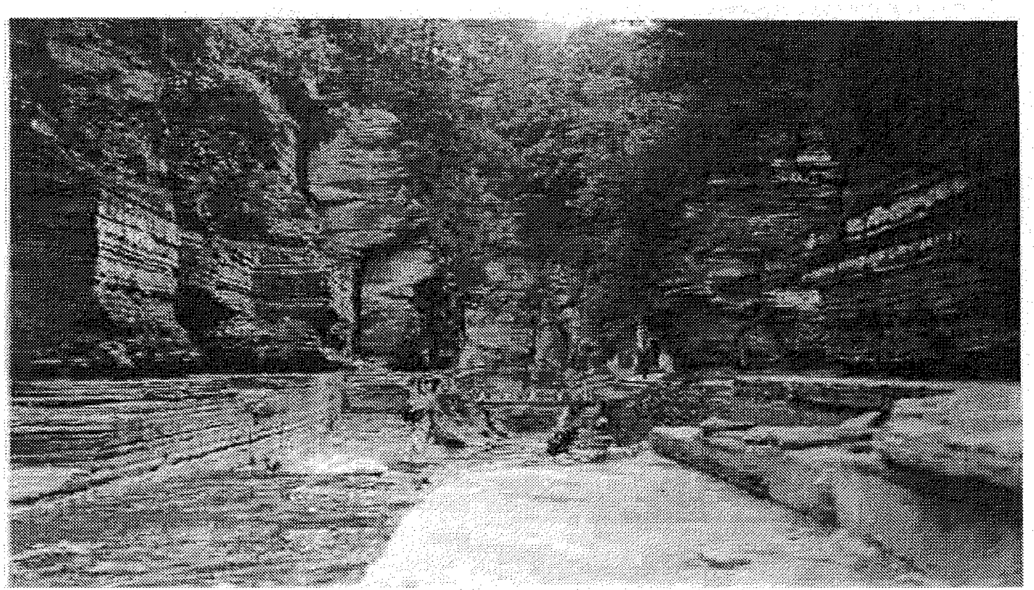
from the Upper Treman parking area.

The top of the "dam" offers an excellent opportunity to observe another glacial feature, kettleholes. These are depressions in glacial drift where large blocks of ice remained and melted slowly after the glacier retreated. These remain today as small ponds. It is easy to walk right by these ponds without realizing that they are unusual in that they have no outlets. This is the clue to their origin. They are preserved much as they were ten thousand years ago. It is worth contrasting these shallow depressions with the gorge. The kettleholes are much as they were when they formed 10,000 years ago, whereas the gorge has undergone erosion in the same time that has drastically changed the appearance of the landscape. Other examples of kettleholes can be found. One can be seen as a pond along the south side of Route 327 just a few more tenths of a mile farther east.

As for the gorge itself, it would be a mistake to think that we have arrived at the present to admire a finished masterpiece of 10,000 years of nature's handiwork. Instead, we should think of the gorge as a chance to watch and admire nature's handiwork in progress since the process is far from finished. One of the reasons visitors are excluded from the trails in winter is so that they will not witness the erosion process too closely. In winter the wet rocks along the sides of the gorge freeze. The water in the cracks swells as it changes to ice, opening the cracks, and pushing the rocks apart until they fall into the creek below and are washed away. Roots of plants and sometimes humans play a role in the erosion of the sides of the gorge, while flowing water itself relentlessly works at removing material from the rocks on the bed of the gorge.

The gorges offer an unusual opportunity to compare the effectiveness of freezing and thawing with that of flowing water. The next time you visit the gorges, look closely at the shape of the waterfalls. Notice that in many cases the water flows out over a rounded protruding surface covering the surface with a sheet of descending water (Figure 2).

It is almost as if the falls had been designed to be attractive rather than following the principles of erosion. However, the protruding rounded surfaces are consistent with the principles of erosion. Because these surfaces are perpetually wet summer and winter, they don't have a chance to freeze. Because they don't freeze and thaw, they don't erode as fast. Although there is a good example of this near the top of Lucifer Falls, there are also outstanding examples at the swimming pool in Lower Treman



6. Figure 3.

Park and at the part of Buttermilk Falls visible from the overlook along the trail that runs up the north side of Buttermilk Falls.

There are other erosion features found in Enfield Glen above Lucifer Falls that often impress visitors as looking man-made. These are the rectangular pools. In this case, it is the joints in the rocks that are responsible. The rocks in the region have a particularly strong jointing pattern with two sets of joints at nearly perfect right angles to each other. These joints formed under tensional forces during the past 200 million years. Freezing and thawing again probably plays the most important role, prying the joints open and forming rectangular swimming pools that look as if they were just made to be swimming pools (Figure 3).

Enfield Falls

Chapter 5 of this book gives a detailed account of the settlement in the area known as Enfield Falls. This was a center of commerce with mills, shops, and a hotel. One of the main industries of Enfield Falls was the gristmill.

The geology influenced the settling of Enfield in many other ways as well. The rolling hills hosted some of the finest timber to supply the early sawmills and provided farmland able to grow corn and other grains. Good soils have grown grass for grazing, making this area excellent dairy country. The good soils in turn depended on the drift from the glaciers and the breakdown of the sandy limestones that the glacier spread southward over Enfield from the limestone ledges near the north end of Cayuga Lake.

Other Parts Of Enfield

Enfield Glen is not the only part of the town of Enfield to show the kinds of features, especially the topographic features, described above. Nearly every north-south valley is a smooth, U-shaped valley; nearly every east west valley is gorge-like. For instance, the village of Enfield itself sits near the center of a remarkably symmetrical, broad, U-shaped valley while Enfield Center Road leading east up the side of the valley parallels a small deeply cut gorge. Some of the broad north-south valleys have strange hummocky floors. Again, the valley that the village of Enfield sits in offers some fine examples of this. These hummocky features are due to some of the drift left behind on the floor of the valley by the glacier. In turn this type of terrain impedes the flow of water and leads to the formation of wetlands.

Bedrock

Although the glacier was the source of some of the most dramatic geologic features in the Enfield area, a thorough understanding of the geology wouldn't be possible without a knowledge of the bedrock, its composition, and its origin. The bedrock found in the town of Enfield is predominantly shale that contains layers of sandstone. These rocks were deposited in a shallow sea during the Devonian period from 400 to 350 million years ago. The material that was deposited had its source in the region of present New England to the east. During quiet periods of deposition, fine silt and clay was laid down in layers. Rates of deposition were slow, averaging about five inches in a thousand years. These thin layers of fine silt and clay are interspersed with sandy layers that were laid down very rapidly at rates of perhaps inches per minute. The rapid deposition was the result of a process known as turbidity currents. These occur when a landslide along the shore occurs or an underwater shelf collapses and stirs up large quantities of mud and sand that then flow across the bottom of the sea, spreading a thick bed of sand. These interspersed layers, now solidified as sandstone, can be recognized in the walls of Enfield Glen with a little practice.

There are three sedimentary formations exposed in the town of Enfield. From oldest to youngest they are the Ithaca shale, the Enfield formation (now known as the Sonyea Groups), and the Chemung sandstone (now known as the West Falls sandstone). Not surprisingly, it is the Enfield formation that accounts for most of the bedrock in the town of Enfield. The Ithaca shale is exposed in Enfield Glen in the lower parts of the gorge and at the lower end. The Enfield formation is responsible for the high cliffs at the upper end of Enfield Glen and for all the rest of Enfield, with the exception of Buck Hill at the southwest corner of the town. Buck Hill, like Connecticut Hill, stands high because it consists of the rather resistant Chemung sandstone. Curiously, these high hills are capped by the Chemung sandstone because there was a down warping of the beds in that area long before the erosion formed the hills. The down warping or syncline left the Chemung sandstone at an elevation where it could slow the erosion rate by forming caps on the hills that eventually became Connecticut Hill and Buck Hill.

The sedimentary layers tilt gently southward so that successively older rock layers are exposed as one travels north along the shores of the Finger Lakes. They were eroded down to nearly sea level 30 million years ago. Since that time they have been uplifted some 2000, feet and erosion formed the valleys that set the stage for the glacier's advance over the region. The old erosional surface or peneplain of 30 million years ago can still be seen as flat-topped hills when one looks south from Enfield.