with irresistible force, and having sand, gravel and boulders beneath it, or frozen into it, was the most potent agent of erosion known. The eroding power of the ancient glaciers, which once reached southward to Trenton and Cincinnati, was attested not only by the planed down rocks, but by the immense sheet of transported debris left by the glacier in its retreat.

The glaciated, planed, and polished rocks in the Western States are generally covered by a thick layer of clay, abounding in glaciated boulders. There are also other water-worn materials which have been transported, perhaps thousands of miles, representing the gravel bars, sand beds, etc., produced by sub-glacial rivers. Although the materials are entirely of glacial origin, all the stones are here usually rounded. We find in these deposits, called kames or eskers, the evidences of the action of running water produced by the melting of ice, their accumulation in heaps, ridges, etc., having been effected by local causes, waterfalls, streams upon or under the ice, etc.

The finer material produced by the same grinding action has been deposited along our coast in the vast masses of the Champlain clays. It is well known that the drainage of all glaciers results in milky streams; *e. g.*, those which descend from the Alps impart an opalescence to the Lake of Geneva, and the streams from the Cascade Mountains are clouded with silt derived from the small glaciers at their heads. So, during the Glacial period all the fine material was sometimes washed out of the glacial drift, leaving banks and ridges, kames, hogsbacks, etc., of gravel and boulders, and carried by streams to the coast and there deposited along shore in the Champlain clays. The fine flour and bran ground by the glaciers have been sometimes referred to different epochs, but they are produced simultaneously. The Glacial or Champlain clays are of great economical importance to the city as they are the brick clays of Croton Point, Haverstraw Bay, and other points along the Hudson. Their thickness reaches 100 feet along the lower portion of the Hudson river, 400 feet on Lake Champlain, 500 feet at Montreal, 800 feet at Labrador, 1000 feet at Davis' Strait, and 1800 feet at Polaris Bay. This indicates that the continent was depressed to this extent at each of these points, that the waters of the ocean extended through these valleys, and that here was dead water into which the glacier drainage flowed and was deposited.

In the vicinity of New York City it is evident that the glaciers everywhere overrode and disregarded the underlying topography. All the surface of the island is strewn with materials derived from the N. N. W., and the rock has been planished and striated with grooves running in that direction. The hills back of Yonkers are covered by trap boulders which have been conveyed across the river from the Palisade range on its western side, and it is plain that the Glacier completely disregarded the depression of the Hudson valley, filled it up to a greater or less extent with *debris*, and so rode smoothly over it. Afterwards this and the other valleys were more or less cleared out by the present streams, but a portion of their contents is generally left in their beds, the tunnel between this city and Hoboken being now driven in fact through a part of this clay deposit. On the east side of the city a narrow cañon, 300 to 400 feet deep, has been proved to underlie the East River; and it would have been a wiser and cheaper plan to construct a tunnel through the clay bottom, for communication with Brooklyn, in place of the present costly and to some extent insecure bridge.

Dr. Newberry finally expressed his interest in the careful study of the erosion and sculpture of the Catskills and desire for its continuance.

MRS. J. M. FISKE has left a bequest of $40,000, to establish a hospital for the use of the students of Cornell University.

RINGING FENCES.*

By PROF. S. W. ROBINSON, Ohio State University.

THIS sketch is mainly of a simple fact of observation. My attention was one day suddenly arrested while walking on a hard road alongside a picket fence by the peculiarity of the sound which reached my ear immediately following each step. This sound was first noticed to be very different from that perceived at other parts of the sidewalk. On instituting an inquiry for the cause of this difference the only one discoverable was a change in the construction of the yard fences along the sidewalk.

The peculiarity observed in change of sound was very marked when passing from a portion of the sidewalk opposite a board fence to parts opposite a picket fence. In the former position a quick drop of the foot upon the walk was accompanied by a simple sound or noise of short duration. But when opposite the picket fence the noise following each footstep was prolonged into a curious musical tone of initial high but rapidly lowering pitch, and with a duration of perhaps a quarter of a second.

This singular musical tone following, and due to the noise of a simple foot step, could only be accounted for on the supposition that each picket of the fence reflected the sound reaching it from the foot, the rapid succession of which, from the several pickets of the fence, resulted in the sound observed.

The duration of the sound reflected from the pickets at each step is evidently due to the different distances of the pickets from the ear of the observer, and the greater length of time required for the sound to travel to and from the more distant pickets. For instance, suppose the observer is walking along a stone or mastic walk at a a distance of eight feet from the fence, the latter extending either way some distance along the street. The sharp noise of the footsteps returns from the nearest pickets first. Here the differences in distance from the adjacent pickets is slight, and hence the succession of reflected noises is rapid. But from more remote pickets the difference of distance is greater, and the succession in reflection less rapid.

In studying the nature of the resulting tone it is at once seen that the initial pitch is due to an almost infinite number of reflections or vibrations per second, while at the end of a quarter, or half, second the lines of advance and return of the sound are nearly parallel to the fence, and hence the pulsations have an interval of time equal twice the constant distance between pickets divided by the velocity of sound. For instance, if the pickets be four inches apart, or one-third of a foot, the terminal pitch would be one of about 1500 vibrations per second. The law of retrogression of pitch may be of interest. To express it as a function of passing time, let

d = distance from observer to fence.
a = constant distance between pickets.
v = velocity of sound.
n = number of vibrations per second.
t = the time following the initiation of the reflected tone.

Then by aid of a diagram we easily obtain the following relation between the above quantities, viz.:

$$\frac{v^2}{4\,a^2\,n^2} = 1 - \frac{d^2}{(v\,t + d)^2}$$

The curve for this equation is not easily classified. But by computing quantities and constructing a curve it is found to be very much like a hyperbola referred to its asymptotes, which indicates that the pitch falls rapidly at first, and less so subsequently.

Not only is the above described phenomenal reflection observed in connection with fences, but from any series of flat surfaces in steps, as, indeed, in the case of stairs under proper conditions. Such echoes have been observed from the steps in front of the State House, at Columbus, O.

*Read at A.A.A.S., Cincinnati.