THE EFFECTS OF WEATHERING AND OTHER CHANGES AT NELSON LEDGES STATE PARK[1]

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Alterations in topography due to weathering, if they can be satisfactorily demonstrated, are enormously useful to teachers seeking to connect the passage of time with geologic change. Even the more imaginative students in geology experience some difficulty in adjusting time-consciousness to the extended periods required to account for gross changes in topography. Students display new comprehension on seeing weathered limestone monuments and spectacular waterfalls like those at Niagara. But prominent features, including waterfalls, erosion along lake fronts with unprotected headlands, and even rainwashed gullies, often fail to convey the significance of the other side of the coin, the infinitely slower land-leveling process which occurs over a greater percentage of the terrain.

The author, while teaching general geology in northeastern Ohio, had occasion to witness the effects of his own overenthusiasm to emphasize rapid erosional forces. When taking students first to a waterfall and later to Nelson Ledges south of Parkman, Ohio, to see the well-known tumbled rocks there, he observed that the huge blocks at the Ledges were immediately (and incorrectly) presumed by students to have moved into their present positions much more recently than closer study revealed.

In the first locality, known as "Forty Foot" Falls (41° 17' N–81° 10' E), just south of the Erie Railroad right of way, 2.9 miles east of Mantua, Ohio, the more spectacular conditions bringing about land-leveling in a young valley were viewed. To add to the inherent sense of rapid change conveyed by the slabs of sandstone at the foot of the falls, a fortuitous rockfall took place during the years this spot was visited; photographs of the cliff before and after the rockfall intensified the lesson.

It was natural, therefore, that students visiting Nelson Ledges State Park, with its gigantic blocks of Sharon conglomerate pitched outward from the mother rock, would translate by analogy (and falsely) the changes there as having taken place "in probably a few hundred years or at most a few thousand."

Stereo-photographs.—Estimating the time at which the blocks were an integral part of the mother rock, or the time they began their downhill slippage, was necessarily based almost wholly on conjecture until a fortunate circumstance offered a moderately tangible means of calculations. An elapsed time of fifty years from which to extrapolate the duration of postglacial times, estimated to be between 11,500 and 20,000 years, is too small to allow for errors of judgment if not measurement; but the observations of the effects of weathering and other changes made with the help of old photographs serve to nullify the hypothesis that rapid slippage is now occurring, and may be of later use to geologists with the passing of the years.

Following a talk given before the Portage County Historical Society, the author was loaned a collection of about forty stereo-photographs treasured as souvenirs of the picturesque Ledges in times past, along with a viewer common in parlors of an age gone by. (These are to be placed in the archives of the historical society by their owner, Mr. Cyrus Plough, of Ravenna, Ohio.) By trial and error the writer and two of his students, Russell Jackson and Miss Jane Corbin, whose work at the Park culminated in the inclusion of their map in a guidebook now available at the park, were able to locate precisely the positions of the stereo-

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camera years before. Thus was presented an effective means, within certain limitations, of studying the relative positions of the blocks on the slope at close range, as well as studing the changes, whenever present, in the pathways, vegetation, rock surfaces and the interior of the interesting cave.

The ledges, past and present.—For those unacquainted with the locality, a brief description will serve to show the prospects offered by old, stereoscopic photographs.

The Ledges represent an upper portion of palisades on the west side of the formerly wide and deep Grand River Valley. Filling by glacial sand and till has almost obliterated this ancient valley. Leverett (1902) gives depths to bedrock near Ashtabula and elsewhere in the Basin, and these permit an estimation of nearly 300 feet of fill now occupying the once impressive gorge. To the east a mile away, Kennedy Ledges, recently added to State Park property, rises as a complement of the west bank, or more likely as an island once resembling in general features the much larger towers in the Grand Canyon of the Colorado (Pettit, 1954). It may be assumed that the sides of the valley were fairly steep and that the massive blocks at one time may have crashed, rather than slid gently, in their trips downhill. The exposures of Sharon conglomerate which compose the Ledges proper extend north and south a mile or more from the central scenic point opposite which the old inn was built. It is pertinent to this account to mention that the signal features at the Ledges lie almost exactly on the St. Lawrence-Mississippi Divide, and as a consequence there is almost a minimum of postglacial erosion from the front of the palisades at the locality being described. Behind the Ledges to the west the terrain rises a hundred feet higher in less than a mile, but surface water drains predominantly away from the Ledges at the inn, and not across in front of it.

At some time or times in the past, large chunks of channel-deposited conglomerate parted from the mother rock, shifting eastward downhill. They are now disarranged in a jumbled confusion, with caves and narrow passageways between. Their bases are, for the most part, deeply buried in debris. The eastern edge of the block furthest from the mother rock is about sixty yards from it; between the furthest block and the mother rock there are intervening blocks which aggregate about thirty yards, horizontal distance. The remaining thirty yards, therefore, comprise the distance the furthest block observable has traveled from its presumed point of origin. By visually comparing opposite faces of intervening blocks, there is adequate evidence that very little material has scaled off, and that if some has done so, an unlikely uniformity of scaling over large areas took place.

The question arising is this: How much shifting of the blocks may be presumed to be transpiring in the immediate past and in the present, and how nearly do the blocks occupy positions they had ten to twenty thousand years ago?

If the present position of the great chunks of stone, some of them fifty by twenty feet in horizontal dimensions and thirty-five to forty feet high, has been reached by movement occurring since glacial times, then the distance travelled might conceivably be enough to be detected in fifty years. Using the smaller number of years suggested by Flint for a locality in Wisconsin, for the time of a lobal advance 11,500 years ago, a block moving uniformly would traverse about an inch-and-a-half in fifty years if its total movement were a conservative ten yards.

In itself, a mere inch-and-a-half would seem to be undetectable in photographs. But in close-up *stereo*-photographs such a slight shift need not exact from the observer so great an allowance for error of estimation. This is understandable when one realizes that stero-photographs permit the alignment of an infinite number of points. When many alignments can be made, particularly with the accountable object very close to the camera, and there is an almost perfect alignment in every

direction matched visually on the spot, it is safe to conclude that movement of as little as an inch would bring distant objects *into* view which are not in view on the photographs, or, at the other extreme, *obscure* presently visible objects in the background. The maximum lateral movement of the block studied intensively would produce an eclipse or a revelation of about ten inches on the background rock face twenty-five feet away, with the edge of the block forming the interception three-and-a-half feet from the camera. One such block appeared on the stereo-photographs.

There is the possibility that the block in question moved directly toward the point from which the picture was taken. There is also the possibility that the background rock moved concomittantly precisely the right distance to cancel the eclipsing or revealing effect. Both these possibilities prevent one from stating flatly that in fifty years, more or less, there has been *no* motion of the block under study. In any case, the alignments are extraordinarily clear, and afford a convincing proof that whatever movement has accomplished the scattering of the blocks it has taken much longer than "probably a few hundred years or at most a few thousand."

"*Gold Hunters' Cave.*"—A wide-mouthed cave (called "Gold Hunters' Cave" because iron pyrites once lured the uninitiated to the spot), extending under the thick layer of solid conglomerate to a depth of about thirty feet, has been a prominent attraction for many decades and consequently appears in several of the old photographs. A cascade descends over the lip of the cave. Its waters soon enter a man-made pond and then flow north as part of the St. Lawrence drainage system. Pictures were taken from within the cave, looking out of the lenticular opening, and also from outside from a point on the path slightly above the entrance; the angle from outside affords an additional helpful perspective for angular studies. Here again an unexpected changless picture is seen. The rocks at the entrance, with one minor exception, are as before. The exception is a slab about eight inches thick and roughly eight square feet in area, lying on a large block in one piece in the photograph taken from within the cave; the same piece is now broken cleanly in two through the middle vertically, and the two pieces are still in view close together in the original position.

Another observable similarity between the photographs and present conditions is the texture of the rock surfaces upon which the cascade has been falling gently for many years. (Recent quarrying operations to the west have cut off the small creek furnishing water to the cascade. In 1955, the writer and the late Mr. Perry Green of Mantua Corners, a man with legislative experience and influence, became interested in endeavoring to have the owners of the quarry reroute the stream to maintain the scenic cascade, but without success. Mr. Green, it should be mentioned, is the individual whose efforts in the interests of conservation and the public domaine led the State Legislature to set aside the Ledges as a State Park, and it is to him, therefore, that the thousands of people using the Park each summer are unknowingly indebted.) If one is accustomed to taking adages at their face value, here is a rock face which denies the adage. A rough estimate of stream flow would place the spring thaw descent at fifty to sixty gallons per minute, and for more than half the year over ten gallons per minute would be a conservative figure. In dry periods, of course, the cascade would have been a mere trickle. A spring at the base of the Sharon about one hundred yards to the south from which the inn draws its supply is said to flow adequately even in the driest years when others in the township fail. The unchanged surface of the rocks at the foot of the cascade, under constant attack as it were, is remarkably out of keeping with what one would expect.

A large log two feet in diameter, believed to be an American chestnut, also lies in the direct path of the former cascade. The same log, exactly in the same position, appears in the photographs fifty or more years old. Not the slightest

alteration of its physical state can be seen. The low temperature, seldom if ever rising above 60° F, has probably greatly favored preservation.

The floor of the cave, however, has changed appreciably. Debris, consisting mainly of iron-oxide-reddened clay from decomposed shale, has accumulated so that the cave floor is approximately eighteen inches higher than it was. Several explanations are suggested. Fragments from the soft, underlying layer of shale outcropping on the back wall of the cave (Meadville or possibly Orangeville—the old Mississipian hilltops meet the Sharon with irregular disconformity in this area) (Williams, 1940), plus a small quantity of the Sharon itself, flaking off from the roof, may have blocked the exit of spring and seepage water, thereby permitting debris to remain longer than in previous times. Increased "human erosion," resulting from greatly swelled traffic by visitors to the cave and their natural curiosity in hunting for fossils in the friable shale, has doubtless contributed debris at a more rapid rate than in past decades. In any case, the elevation of the cave floor is the sole evidence of geologic change within the wide scope of the photographs which are clear and sharp.

Additional, interesting comparisons are worthy of mention.

Vegetation.—The vegetation has changed so completely that a majority of the photographs defied orientation if unique surfaces of rocks did not appear in them; and unique surfaces, when dealing with distant views, were difficult to identify. The alteration of vegetation might easily be termed absolute in identified pictures; this is with reference to trees and shrubs. A great many unidentified pictures, indeed, might be suspected of being taken in glens in a different county were it not for the imprint of the name "Nelson Ledges" on them (along with a quaint subtitle on each, a fancied resemblance to an animal or some harmless (and timeless) activity of harmonious young couples walking in shaded, wooded paths).

The wedging capacity of tree roots might be expected to exert full force amid the cracks in the rocks observed here and there. Unfortunately, there were no photographs allowing comparisons of this often cited activity of plants. Roots may have played their part in widening minor cracks on a small scale, but the huge masses of conglomerate are not fair tests of the power of roots to expand cracks.

Case-hardening phenomenon.—The persistence of pebbles in exposed rock surfaces deserves brief description. Identification of the block most intensively studied was actually made by background-recognition initially; next, its silhouette confirmed its identity; lastly, the pattern of its surface verified the original impression. These steps took a matter of seconds. Upon careful observation of the rock itself, through the viewer and then visually, the remarkable fact of the persistence of the original pebbles led to the conclusion that the edge of the rock used in triangulation and alignment was virtually unchanged, and that almost every pebble in the photographs was still lodged securely in its sandstone matrix.

As mentioned previously, quarrying of the valuable pebbles and sand (the former for refractory brick) is cutting off the Ledges from the continuous layer of Sharon extending for miles to the west. If one walks to the most recently quarried conglomerate, he will discover that the pebblestone when freshly exposed is so friable that it disintegrates under blows from his boots. Proceeding southward to older portions of the quarry, one encounters harder and harder pieces left behind by the machines, or thrown up by blasts which loosen the material to be carted away. The oldest pieces are much more resistant to crushing underfoot. This leads one to the hypothesis that after exposure the characteristics of the conglomerate change. Moreover, the ancient rocks at the Ledges themselves show concentrations of iron as sulphides and oxides on the surface, flintlike in their resistance to abrasions. Without question, the hard surface of the rocks has enabled the quartz pebbles to persist almost without change, and one may speculate that solution and frost-wedging proceed at a very slow pace for the same reason.

One more observation should be included and that is the sculpturing and pitting, particularly where cross-bedding is evident. How long these indentations, some of them deep enough to receive a large banana easily, have existed in their present form is an interesting question. They are even more pronounced on the rock walls at Kennedy Ledges across the valley. A strong similarity these pits bear to some appearing at Cascade Park in Elyria, Ohio, warrants a suggested explanation and an important possible connection with the conditions giving rise to them. At Cascade Park, the pits occur at the sides of a former river channel, now high and dry above the sizable Black River. The channel was once at the brink of a falls. It has become dry by virtue of stream piracy. The side walls of the falls must have been subjected to continuous and intensive washing and abrasion by *large volumes of water*, with the less resistant grains of sandstone washing out, leaving characteristic pitting of the surface. Transferring our attention to Nelson Ledges, we observe that the pits follow the lines of fore-sets in the cross-bedding where differential conditions of deposit are evident in the graininess of alternating layers. Could it be that the pits come into being *not* from the trickles of water that seep from within these isolated remnants detached from the main aquifer, and not because of rains which occasionally strike them (a possibility which is further excluded by the fact that the pitting is equally prominent on overhanging surfaces) as would be required if the blocks had been detached *since* glacial waters ceased to flow, but rather from *large volumes of water* which bore sediments with powerful abrasive action? If torrents of water are needed to produce the pitting, then the blocks may well have assumed their present positions at the time the glaciers were melting and receding. A quality of *changelessness* thus seems to emerge as the most prominent feature of the Ledges, insofar as gross, recent alterations in topography at this locality are concerned.

CONCLUSIONS

The combination of evidence and deduction lends credence to the theory that the massive blocks of conglomerate at Nelson Ledges State Park have changed very little either in position or configuration in the thousands of years since the melting of glacial ice in the Wisconsin ice age.

The quality of changelessness may here be held before students, to offset the impressions they may erroneously gain from seeing spectacular and dramatic geologic activity elsewhere.

The value of this locality is enhanced for instructional purposes by having available some objective evidence favoring lack of change in the form of stereophotographs which may readily be copied for these purposes.

From information of this sort, adapted to the level of understanding of classes visiting this spot, the education of the very young and secondary school students in matters of deductive logic (at an age scientific attitudes are very likely developing), as well as the testing of logical mental processes among college geology students, may be advanced.

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