

A STUDY OF THE COW BAY BEACHES.—BY D. S. McINTOSH,  
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(Read 10 April 1916)

INTRODUCTION.

For many years, the Cow Bay beach has been a summer resort for the residents of Halifax and Dartmouth. The wide expanse of sand and pebbly beach open to the ocean attracts bathers, and the sheltering groves of spruce within a stone's-throw of the sea has become a favourite spot for picnicing parties.

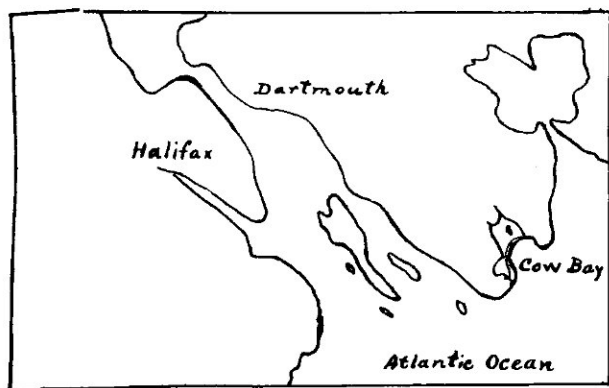


FIG. 1.—LOCATION OF COW BAY.

A drive of six miles by automobile or carriage over a macadamized road from Dartmouth through Woodside and along the harbour-front to Eastern Passage, followed by that over a less level and less smooth road for four miles is the usual way of reaching the locality which lies a few miles to the East of Halifax harbour. The recently constructed "Halifax and Eastern" railroad passes within about a mile of the beach, and will likely have a station near.

## STATEMENT OF THE PROBLEM.

This beach is one of several similar beaches along the Atlantic seaboard of Nova Scotia. The most striking characteristic of this coast is the irregularity of the shore line with its numerous islands—the result of relative coastal subsidence. The channels made by the streams in the quartzites and slates of the area when the land stood higher are now invaded by the sea, and their lower courses are estuaries. In these estuaries, beaches have formed, ponding back fresh or brackish water. Cow Bay beach is neither the largest nor the smallest of these beaches, but has been selected for study on account of the presence back of the present shore-line of a series of beaches older than the modern beach. The purpose of this paper is to account for the present form of this beach—the modern storm beach with the older beaches lying behind. It is hoped, too, that the conclusions arrived at in regard to modern coastal stability are of value, and make the paper one of more than local interest.

## GENERAL DESCRIPTION.

The general direction of the coast-line east of Halifax is about east-northeast; that of Cow Bay about northeast. The extent of the bay inland from the line of headlands is about a mile. The length of the beach under discussion is about three-fourths of a mile, the eastern corner of the bay having another beach with ponded freshwater. The pond or lagoon back of the beach extends inland for about a mile. It is shallow, and over a large part, the bottom is chiefly drifted sand overlaid by decaying organic material. In the pond is a comparatively large island, the outline and attitude of which is similar to that of the hills in the vicinity. This island appears to have been protected from the sea-waves, even before the present beach was in existence, as it shows no evidence of marine wave action.

On account of the filling up of the pond by material washed over the beach and by wind-borne sand, it is difficult to locate, with any degree of certainty, the outlet at any particular time while the beach was in process of formation. The depth of water and the low cliffs on the north-east side of the island seem to point to the presence there, at some time, of a water course. Doubtless, the outlet has been

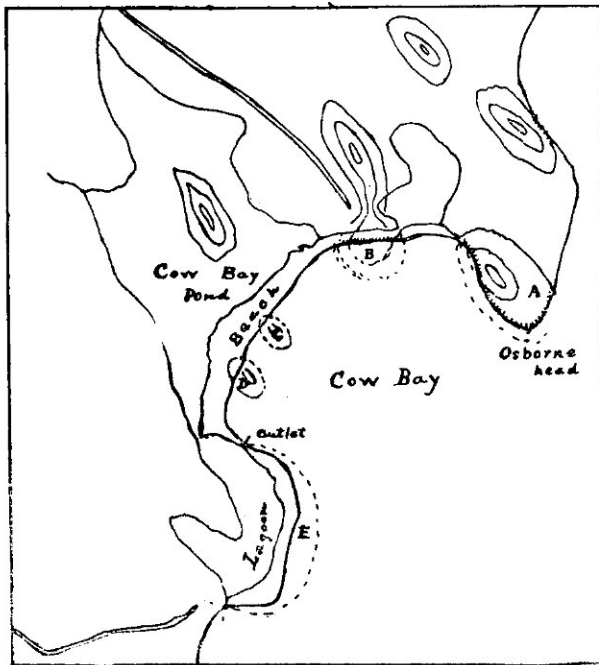


FIG. 2.—LOCATION OF PRESENT-DAY AND RESTORED DRUMLINS.

generally shifted towards the western end of the beach by the prevailing trend of the shore-currents. Within the recollection of the present inhabitants, the water of the pond has been fresh, and drained into the lagoon to the west of the beach (See Fig. 2). About fifteen years ago, however, a storm closed the outlet of the lagoon, the ponded water rose

and burst through at the present outlet, a hundred yards or so from its former exit. A breakwater was then built here to provide a boat harbour. Since then, the water of the pond has been brackish. The lagoon to the west is flooded during high tide, largely through the outlet, but also over a low part of the beach on the western headland.

The surface irregularities of the locality and the surrounding country consist chiefly of rounded elliptical hills with the longer axis approximately south-east and north-west. This direction conforms to that of the glacial scratches on the bed rock. These hills are made up of drift-material, and are therefore drumlins. Some of these drumlins are shown in Fig. 2.

#### THE DRUMLINS.

These drumlins enter largely into this discussion. Some of them are entire, others are partially wave-eroded, while two show but the wave-sorted base remnant. The western half of the promontory which ends at Osborne Head—drumlin A (Fig. 2)—has the seaward portion wave-eroded so as to produce cliffs. The waves still attack the south-eastern end and are wearing it away, but the cliffs on the side facing Cow Bay are largely grass-covered with shelving beaches extending to the sea. This condition does not, however, seem to have been brought about by elevation of the strand-line, but is rather the result of the seaward building or prograding of the beach, so that the foot of the cliff is now beyond the reach of the waves. Drumlin B (Fig. 2), at the eastern end of the Cow Bay beach, is partly destroyed by wave-action, but the site of the eroded part is shown by the boulder-strewn bottom which extends seawards a hundred and fifty or two hundred feet. It was from a study of this foundation material that it was possible to restore drumlins C, D, and E (Fig. 2). Although the rock of the area is slate, the boulders of the drumlins are quartzite with a sprinkling

of granite from the district to the north. From the eroded part all the finer material has been washed away by the waves, and but the coarsest remains. The boulders in this part of the site, moreover, are not rounded by the waves, but are typically glacial, and they appear not to have been moved from their position in the drumlin, except in so far as they have fallen from an upper level to a lower. A boulder bottom thus fringes the seaward end of the partly eroded drumlins. West of drumlin B about five hundred yards along the beach is a drumlin site C as indicated by the boulder-covered bottom. Nothing but the coarser material remains. A few yards further along towards the west is another drumlin site D. The area that forms the south-western boundary of Cow Bay is also fringed seaward by a boulder-strewn bottom, the remains of a former glacial mound E.

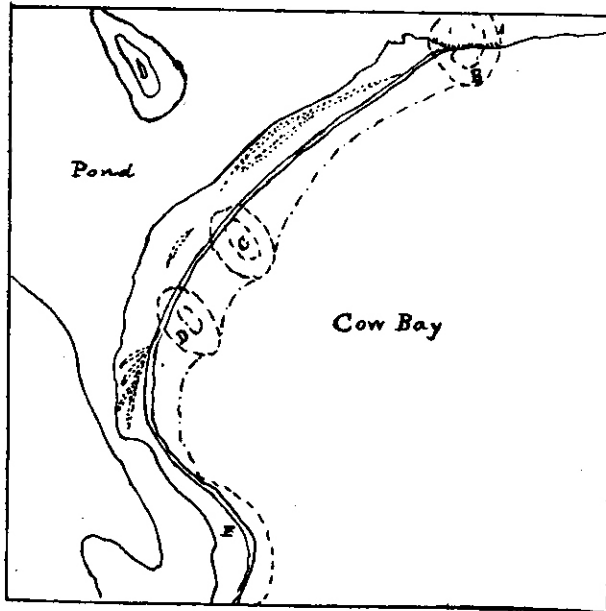


FIG. 3.—BEACHES—MODERN, FULL LINES; OLD, DOTTED LINES; PROBABLE EARLY BEACH, DOT AND DASH LINE.

## THE BEACHES.

The beaches under discussion extend for about three-quarters of a mile with an average width of about four hundred feet. The seaward side is open crescent shaped; the pond side, in general, concave, but with tongues of gravel and pebbles extending into the pond at several places, and pond-made material irregularities in others. These tongues of pebbly material were formed by the action of waves carrying cobbles over the storm beach. Beginning at B going towards the west, (See Fig. 3), the beach for about a hundred and fifty yards has a gentle slope, and beyond the reach of ordinary storms, is ridged with small sand dunes, while the pond side holds scrubby spruces. From this point at the cres, two beaches branch, one a low modern beach, the other an old one. These diverge slightly as they continue westward until at about one hundred yards further west, this old beach divides into two, and the three continue towards the west very gently crescentic for a hundred yards or so. At this point, the farthest back beach is fifty feet from the middle one, and the latter about seventy from the modern. The area here is wooded along the line of beaches with intervening sand patches—the beaches are cobbles. The pondward old beach continues west, coalescing with the other old beach and preserving about the same distance from the modern beach until in a line with the restored outline of drumlin C. In the drumlins C and D area, the modern beach is low with small grass-covered sand dunes pondward and a low old beach about forty yards back of the modern, and with marshy material to the edge of the pond. From the drumlin site D the modern beach continues to rise towards the west until about half-way to the outlet, it is steep as is possible for the cobbles to rest on one another, and is ten and a half feet above the last high tide. This part of the modern beach continues high up to near the outlet. Back of this high modern beach is a series of low old beaches in a

sort of fan shape, spreading out towards the pond outlet and converging towards drumlin *D*. The ends of the fan curve down stream. These beaches lie nine and a half feet below the high modern beach (See Fig. 4). Of the two old beaches to the eastward of drumlin *C*, the furthest back is higher than the modern beach at this part. Here the crest of the modern storm beach is six feet five inches above the last high tide, while the old beach is eight feet two inches to ten feet four inches above the same mark. This latter is, at its highest part, a flat dome-shaped mass of flat cobblestones now lichen-covered (See Fig. 5). Towards the pond side and towards the westward margin, the stones are smaller than on the summit and towards the east.

#### STORMS AND THEIR EFFECTS.

The frequency and intensity of storms along this coast for the ten years previous to 1912 is contained in "Wind Data" compiled for the Halifax Ocean Terminals. In this compilation, it is shown that, as one would expect from the latitude of the locality, by far the greatest number of storms has been from the south-west. As this wind blows along the shore, the only effect is seen on the headlands where the beach material is being moved eastward. Where, however, as at Cow Bay the beach is protected from this wind, little effective action of the waves and littoral currents is shown. North-east storms, which are few compared with the south-west, also blow along shore, and have a like effect, unless somewhat east of northeast. The heaviest storm recorded for the ten years blew from this direction with a velocity of over sixty miles an hour. Such a storm would doubtless drive great waves into the bay with an accompanying littoral current. South-east storms are more frequent than north-east, and as the bay lies open and exposed to the full force of the Atlantic waves, the effect should be great, especially when the storm is accompanied by a high tide. It is,

indeed, surprising, at first glance, to see boulders of comparatively small size unmoved from the wave-swept drumlin base. This is owing, however, to the shallowness of the bay for some distance seaward. In heavy storms, a line of breakers is formed off-shore, and the force of the waves diminished.

#### ORIGIN OF THE BEACHES.

The material of which the beach is composed came from the easily-eroded glacial mounds, and appears to have been carried largely towards the west. On the seaward side of the present beach were at least two islands *C* and *D* (Fig. 3). It is not unlikely that between *B* and *C* were one or more small islands further seaward that protected the island in the pond from the waves before the beach was formed, and which were early destroyed. While the drumlins *A* and *E* extended further seaward than today, the islands were more sheltered than later. The on-shore storms would, however, act upon them, and their reduction was begun. With shallow water, as today, and a current along the shore, the tendency would be for the waste from the drumlin-heads to be carried in the direction of the current, and to form bars which might eventually tie the drumlins, as in Fig. 3. As the waves cut back the drumlins, these beaches would be driven further towards the pond-head. There was, probably, a channel kept open by the currents for some time between *B* and *C*, but this was gradually driven towards the western end of the beach, until at length the water from the pond emptied into the lagoon. When the drumlins were consumed, or but shreds remained on the rear, the beaches were located slightly seaward of the oldest old beach of today. So much material had by this time accumulated that, under ordinary conditions, the movement of the beaches landward was ended. A violent storm, probably accompanied by a high tide, next swept the shore. Its work was most effective in the wider space between *B* and *C*, and



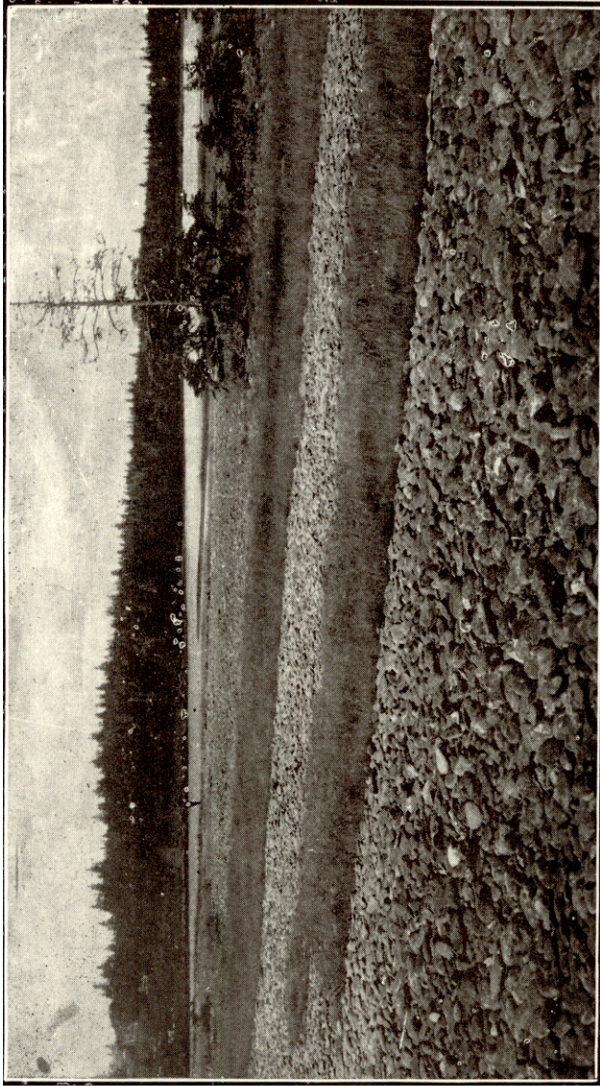


FIG. 4.—LOW OLD BEACHES.

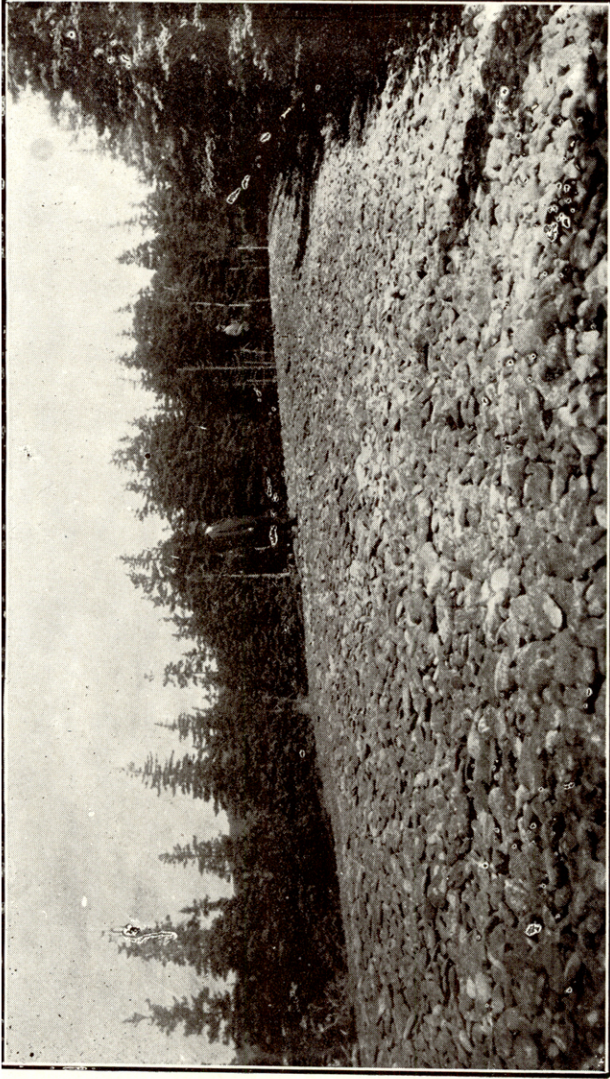


FIG. 5—HIGH OLD BEACH.

where already the beach was highest. The sand, pebbles, and cobbles were carried by the westerly trending current and heavy waves over the high beach and spread to the edge and into the pond, leaving the crest of this highest old beach dome-shaped as at present. This height was not again reached by the waves, and the beach prograded, and another storm beach formed, making the second old beach in this part. This latter forms an arc of a larger circle within the arc of a smaller one, the oldest beach. Prograding has continued to the present modern beach.

In the western part of the beach after the destruction of the drumlins, the force of the waves was reduced by sweeping over the drumlin-base. The seaward old beach is probably of the same age as one of those to the east, while the low ones lying behind seem to have been the result of storms carrying material over a low storm beach through troughs in the beach and into the western part of the pond where it joined the lagoon. The development of a high modern beach has preserved them in their present form.

#### EVIDENCES OF THE AGE OF THE BEACHES.

The oldest beaches reached their present position when, or soon after, the work of consuming the drumlins was completed. For several years they were, doubtless, like the ordinary beach without vegetation. Now they are fringed with spruce trees. A stump of one of the largest of these trees about two feet in diameter shows one hundred and twenty annual growth rings. The younger old beaches are also bordered with trees but of a smaller size. The low old beaches have, in places, their margin covered with from six inches to a foot of firm marsh-grown peat which must have taken many years to accumulate. The minimum age of the oldest beach may be fixed at about a hundred and fifty years.

## CONCLUSIONS.

The Cow Bay beaches were the result of wave erosion influenced by littoral currents operating upon the glacial material of islands and hills in and around the bay. The process was mainly that of lateral tying. Until the drumlin islands were consumed the beach retreated; afterwards, it grew seaward. The age of the oldest beach is not less than a hundred and fifty years or thereabouts, however much older it may be.

In connexion with old beaches, there naturally arises the question of elevation or subsidence of the shore-line. The subject is one that has, during the last few years, received a good deal of attention. The statement that the north-eastern coast of North America is at present sinking at the rate of about one foot per century has been disputed. Detailed work has recently been done in several places along this coast, and Dr. Douglas W. Johnson, in an interesting paper,<sup>1</sup> shows that much evidence that has been adduced in support of elevation and of subsidence can be otherwise explained. From his study of the Nantasket area, in collaboration with Mr. W. G. Reed Jr., the conclusion is reached that "no marked changes in the relative position of land and sea have occurred in that locality during the last thousand years at least."

In the Cow Bay area, there appears to be no evidence that necessarily points to elevation of the coast-line. The grassed cliff on the partly eroded drumlin A, with its shelving beach, is the result of wave erosion succeeded by prograding of the beach brought about by the accumulation of the abundant material driven in from Osborne head. The highest old beach is the work of a heavy storm. The evidence is strong in favor of this explanation. This beach is, moreover, not higher than the high modern storm beach at the western

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<sup>1</sup>. I. DOUGLAS W. JOHNSON, *Vizite de la Cote Atlantique de l'Amerique du Nord* (Annales de Géographie, tome XXI, 1912, pp. 193-212).

end of the bay. And, again, had there been elevation, the lowest old beaches would not be as they are today, just above the high water mark. Nor is there evidence of depression shown by the low old beaches. They resulted from storm action. These beaches are, then, rather the effect of waves upon a stationary coast—one which has remained so for at least a hundred and fifty years.

#### ACKNOWLEDGMENTS.

The writer wishes to thank Mr. James McGregor for the use of "Wind Data", and Dr. Douglas W. Johnson for a copy of his paper on the stability of the Atlantic Coast of North America. More especially does he feel under obligations to Dr. J. W. Goldthwait for valuable suggestions and for photographs (Figs. 4 and 5) which, through the courtesy of the Canadian Geological Survey, he was permitted to use.