

ART. XXXI—*The Hawera Series, or the So-called "Drift Formation" of Hawera.*

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THE "drift formation" which is the subject of this paper was so termed by Park in 1887 in his paper "On the Geology of the Western Part of Wellington Provincial District and Part of Taranaki"\* Park divides the "Recent and Pleistocene" into—

- (a.) Blown sands, river-terraces, and superficial pumice deposits.
- (b) Drift formation of Taranaki and Wanganui.

Using "Notopleistocene" instead of "Recent and Pleistocene," I am in full accord with Park in this classification. The "drift formation" is very well displayed on the coast-line between Wanganui and Hawera, and lies in age between the Wanganuiian beds and the superficial blown sands and river-terrace gravels of the district. The superficial pumice beds to which he refers cluster around Mount Ruapehu, and do not extend into the area under consideration.

Park gives the following description of the "drift formation".—

"This formation is very widely distributed, and extends as a maritime belt from the Ruahine Range to the foot of Mount Egmont; and, on the North Taranaki coast, from New Plymouth to the Mokau. At Kawaiki it occurs at an altitude of 400 ft above the sea, but at no other place has it been observed at a greater height than this.

"It consists of stratified sands and clays that are usually micaceous, and of a yellow or red colour, and coarse gravels that are often cemented by iron-peroxide into rusty conglomerates. Near the volcanic centre of Taranaki the gravels consist chiefly of igneous rocks, while east of the Rangitikei they are composed of siliceous sandstones and dark slaty shales.

"The drift is well exposed in the cliffs between Wanganui and Patea, and a great many opportunities are presented of closely studying its character. Drift-timber and upright stumps of trees occur in most places at its base. These are covered or mixed with gravels, in which marine shells are sometimes found in small patches or irregular layers. There appears to be no regular order of superposition of the various beds of the drift. For short distances the drift-timber and gravels are absent, or more frequently appear at the top of the series, and the yellow sands and clays lie directly on the Tertiary clays or limestones.

"At most places on the coast between Wanganui and Patea the Tertiary strata are but slightly inclined from a horizontal position, and where immediately succeeded by the stratified sands and clays of the drift there is no apparent unconformity between the Pleistocene and Tertiary formations. But, although at special points it is difficult to determine an unconformity, this is made quite clear by the manner in which the drift is found resting successively on the different members of the Tertiary formation. At Wanganui it lies on the upper sandy beds, and proceeding along the coast, on the rise of the beds, it may be seen resting alternately

\* *Rep Geol Explor during 1886-87*. No 18, 1887, pp 24-73 (ref to pp 57, 59-60)

on the Kai Iwi blue clays, Okehu beds, Waitotara limestone, Whenuakura and Patea clays. On the Taranaki coast also it lies on the younger Tertiaries between the Waiiau and the White Cliffs, and on the Cretaceous-Tertiary strata at the Mokau.

"The submerged forest already alluded to as underlying the drift is associated with a bed of lignite of variable thickness, which is well exposed at Languard Bluff, and in many places north of Wanganui.

"It is remarkable that, although the drifts extend inland a great many miles, the evidences of a submerged forest and lignite are never met with more than a mile or two from the present shore-line, and then only in low-lying areas. It would thus appear that this ancient forest flourished in a narrow belt of low, swampy land adjacent to the sea. The occurrence of irregular beds of marine shells at the base of the drift points to the existence of shallow brackish lagoons within the influence of the tide. The shells are all marine and Recent, and include the following forms: *Venus stutchburyi*, *Venus mesodesma*, and *Turritella rosea*."

My own observations of this formation concern only parts of the coast between Wanganui and Hawera, along the whole of which it is well exposed in the sea-cliffs. My visits to this coast were primarily for the purpose of collecting fossils from the Wanganuiian beds, and it was only at the sea-cliff at the "Zigzag," near Hawera, that I made any detailed notes of the Notopleistocene beds. This cliff is about 200 ft. in height, the lower 50 ft. being composed of mudstone (papa), the exact horizon of which cannot be quite definitely stated at present. It lies in nearly horizontal beds which continue without any appreciable dip along the coast as far as the head west of the Patea River. The Hawera papa is thus probably of about the same age as the Patea blue clays, which are placed by Park below the *Ostrea ingens* bed of Waitotara. It is certainly older than Castlecliffian, and is probably Waitotaran.

The upper 150 ft. of the cliff at Hawera, with the exception of a superficial layer of a few feet, consist of the so-called drift formation, which is here better displayed than at any other point, and which, therefore, I propose to term the *Hawera series*, using that term in a purely local stratigraphical and not a general systematic sense. It is in the main composed of loose sands which are thin and irregularly bedded, and in places exhibit good current bedding. In the lower half there are several layers of blue clay, each about 1 ft. thick, interbedded with the sands, and formed presumably by a rewash of the papas. There is at least one seam of lignite in the lower half, while at the base there is a gravelly shell-bed resting on a surface of hard papa bored by the molluscs *Barnea* and *Venerupis reflexa*. Owing to the predominance of loose sands the cliff is much obscured by slipped material, and it would be a matter of difficulty to give a detailed account of the order of succession of the various beds; nor is this especially desirable, since the beds vary rapidly in a lateral direction. The sands in the lower half are loose, and are often dark owing to an abundance of green and black ferruginous minerals. Some layers in the lower third contain quite large flakes of both black and white mica. The layers in the upper half are harder, owing to the presence of a ferruginous cement resembling a bog iron-ore. The bedding, except where current bedding occurs, is approximately horizontal.

The wind-blown sand which forms dunes resting above the *Hawera series* lies unconformably upon it, and is doubtless derived from it. This is important from an economic point of view, as showing the source of the

chief ironsand deposits of southern Taranaki. They are not blown up from the present beaches, but are derived nearly *in situ* from the Hawera series, and their elevation is largely due to the movements which brought that series into its present position. Few layers of the Hawera series are themselves sufficiently rich in iron minerals to deserve the title of iron-ore, and it is the second sorting, by wind-action, which has produced the concentration found in the ironsands.

The Hawera series can be traced continuously all the way on the coast-line between Hawera and Wanganui, except where large graded rivers like the Patea and Waitotara enter the sea by wide valleys. The series is seldom so thick elsewhere as at Hawera, but its composition remains much the same, and the presence of the bored papa beneath it may be seen at a number of points, although shell-beds similar to that at Hawera are not extensively developed. West of Waitotara in the basal bed there are occasional boulders of andesite of a much larger size than those near Hawera. At Castlecliff there is a strong bed of lignite developed.

The drowned forest so clearly displayed at low water near the mouth of the Waitotara River cannot belong to the Hawera series unless this has been dropped by faulting some 50 ft. in this area, a supposition for which I found no other evidence. Since its formation the Hawera series has undergone elevation to a fairly uniform level, but this forest, together with a similar one which I am informed exists in the Patea River, points to a recent movement of slight depression on this part of the coast-line. Park observed that, although the "drift formation" extends inland for many miles, the evidences of submerged forests are never met with more than a mile or two from the present shore-line, and then only in low-lying areas. From this he draws the inference that this forest flourished in a narrow belt of low swampy land adjacent to sea; but the facts support a different explanation. The forest apparently flourished in the flood-plains of the Waitotara and Patea Rivers, and is only found submerged and partially buried with estuarine mud near the mouths of these rivers, because these were the only areas, with the exception of the sea-beaches, which were carried below high-tide level by the slight movement of depression. On the other hand, the lignite-beds which Park associates with the drowned forests in mode of occurrence are certainly an integral part of the Hawera series.

The unconformity of the series to the Wanganuian is shown not only by its resting in turn on all the Castlecliffian and Waitotaran beds between Castlecliff and Waitotara, but also by the bored surface existing beneath it, and by the existence of faults which have affected the Waitotara beds prior to their truncation and to the deposition of the Hawera series upon them. A section illustrating this last feature very clearly is exposed on the cliffs west of the mouth of the Waitotara River.

The mode of formation of the Hawera series seems, from the above observations, to have been much as follows: The Wanganuian beds after their deposition were elevated considerably above sea-level, and also slightly tilted, and were attacked by subaerial and marine erosion. An extensive plain of marine denudation, backed no doubt by sea-cliffs, was thus cut across their upturned edges, and upon this the shell-beds were laid down, followed by sands and layers of mud as marine erosion carried the cliffs landwards. The sands were no doubt in part derived from the coarser material washed out of the Wanganuian beds, and a part of their content of dark minerals may also have been derived from this source, for the papas of Hawera contain volcanic minerals, but the boulders of andesite

in the Hawera series, and probably a large part of the sands, owe their origin to the material brought down by rivers from Mount Egmont. A cessation of cliff-recession followed, either from elevation or because the supply of waste became sufficient to produce a prograded coast similar to that of Marlborough, and a low-lying coastal strip in which lagoons and ponds could form gave rise to the ferruginous cement in the upper layers of the series. Finally deposition was brought to an end by elevation of considerable amount.

My own observations do not permit me to state how far inland the Hawera series extends from the present coast-line, but between Wanganui and Hawera Park's map does not show it more than six miles inland. From the top of the large sand-dunes seaward of the railway-station at Okehu one sees in a north-east direction two distinct terraces, one with cliffs facing the present beach, the other with cliffs parallel to the former series and facing the lower terrace. These latter cliffs cross the Okehu and Kai Iwi Streams transversely, and thus have no immediate relationship to the present drainage. They must be either fault-scarps or old sea-cliffs, and their general parallelism to the present sea-cliffs makes it probable that the latter explanation is correct, and that they mark the limit of inland extension of the Hawera series. The lower terraces will in that case be typical coastal plains. Farther inland towards the headwaters of the Okehu and the Waitotara there is a still higher terrace, much more dissected, and with wooded tops. It is possible that there are a number of older Notopleistocene series, similar in mode of occurrence and formation to the Hawera series, resting on the inland terraces.

The fossils obtained from the Hawera series at Hawera comprise the following species: *Pecten triphooki* (derived fossil), *Ancilla australis*, *Anomia walteri*, *Arca decussata*, *Calyptrea maculata*, *Calliostoma punctulatum*, *Cardita calyculata*, *Chamostrea albida*, *Chione crassa*, *Chione stutchburys*, *Corbula zelandica*, *Crepidula costata*, *Diplodonta globularis*, *Dosinia subrosea*, *Euthria lineata*, *Glycymeris modesta*, *Glycymeris laticostata*, *Leptomys lineata*, *Mactra scalpellum*, *Mesodesma subtriangulatum*, *Mesodesma australe*, *Modiolus australis*, *Mytilus magellanicus*, *Natica zelandica*, *Nucula hartvigiana*, *Ostrea angasi*, *Pecten zelandiae*, *Syphonalia nodosa*, *Submarginula intermedia*, *Trochus chathamensis*, *Trochus viridis*, *Trochus taratus*, *Trivia zelandica*, *Turritella rosea*, *Venerupis reflexa*, *Venericardia difficilis*, *Hemithyris nigricans*, *Terebratella rubicunda*, *Terebratella sanguinea*, *Evechinus chloroticus*. All these fossils, with the exception of the rounded, worn, and obviously derived fragments of *Pecten triphooki*, belong to Recent species. It does not seem probable that the raised beaches of different heights which are known in various parts of New Zealand will ever be correlated or distinguished satisfactorily by their marine faunas, but where vegetable fossils are found in the Notopleistocene rocks it is quite possible that owing to climatic changes a succession of floras may be distinguished on which an age classification may be established.

The study of such Notopleistocene deposits as the Hawera series is exceedingly important from an economic point of view, for most of the richer soils of the Dominion lie on such deposits. The famous dairy-farming land around Hawera is floored by the Hawera series, and not directly by the Wanganui papas. This paper does not profess to treat of the subject exhaustively, but it is hoped that it will cause this series to receive more attention than it has attracted during the last thirty years.

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