The Ecology of the Inner Islands of the Hauraki Gulf

Chairman: Mr. E. G. Turbott

Outline Geology of the Inner Islands of the Hauraki Gulf

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The geology of Waiheke, Ponui, Motuihe, Motutapu, Rangitoto, and associated islands (Fig. 1) can not be considered separately from that of the adjacent Waitemata Harbour and Auckland Isthmus, for their lithology, structure, and geologic history are intimately connected.

The basement rocks over the whole region consist mainly of indurated, sparsely fossiliferous, bedded sandstones and argillite of probable Jurassic age (Waiheke Formation). Less frequent red and brown cherts and jaspilites are found on Waiheke, Pakihi and Motutapu, on the first two being associated with quantities of manganese ores which were once quite intensively mined. Also at a number of points on Waiheke grey and reddish lavas are found interbedded with the sediments.

These sediments were laid down in a trough, the New Zealand Geosyncline, which stretched from somewhere south-east of New Zealand throughout the length of the two islands in the form of a curved Z (which may once have been almost straight) and continued north-west on to New Caledonia and Indonesia. This trough formed the edge of the continental shelf which bordered a land of high relief situated in the present site of the Tasman Sea.

An uneven surface has been developed on these beds by erosion during Cretaceous and/or lower Tertiary times, on which were deposited sediments of very varied types belonging to the Waitemata Group of Miocene age.

Waitemata sedimentation began with the deposition of discontinuous, sometimes fossiliferous conglomerates in hollows in the pre-Waitemata surface. As subsidence continued, deeper-water sands and silts accumulated, and these in some places (e.g. at Oneroa and Church Bay, Waiheke) are richly fossiliferous, indicating that the area supported a very varied fauna in rather localized pockets at times during the depositional history. Sea level fluctuated con-

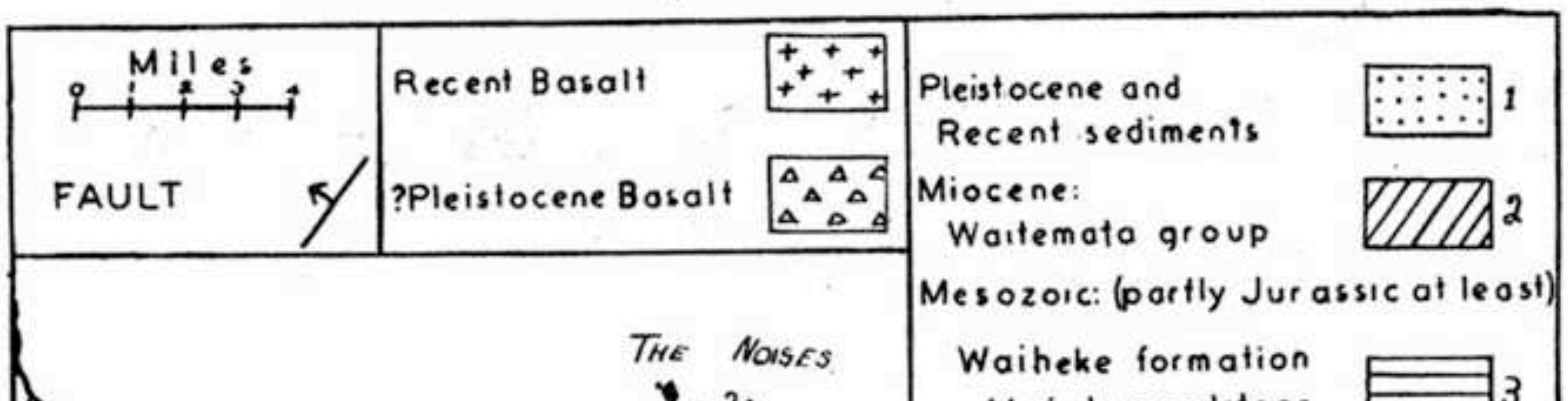

FIGURE 1.—*Geological Sketch-Map of the Inner Islands of the Hauraki Gulf, and Adjacent Area (after Brothers, Halcrow, Searle, Schofield).*

siderably during the period resulting, especially in the Motutapu area, in interbedded fossiliferous grits and muds and barren sands. One feature of special paleoecologic interest is the concentration of plates of the giant barnacle *Hexalasma aucklandica* in Waitemata beds near a high in the pre-Waitemata surface on the west coast of Motutapu. This suggests that the barnacle, a sessile type, lived attached to the high, which existed at the time as a pinnacle or sea stack, and shed its plates into the sea around to become entombed in the sediments which were slowly burying the high.

During these times eruptions of intermediate volcanic material (andesites) took place in the Waitakere Hills region to the west. Ash from these eruptions was spread subaerially, and subaqueously, and apparently discontinuously, over much of the isthmus and it is represented on Motuihe by a thick tuffaceous sandstone.

Today remnants of Waitemata sediments are preserved in pockets surrounded by older rocks on Waiheke, Motutapu and Motuihe.

At the end of the Tertiary the whole Auckland region was subjected to tectonic stresses and broken by major N.N.W.-S.S.E. and E.N.E.-W.S.W. faults into earth-blocks which moved differentially. To the east a structural trough, the Hauraki Graben, resulted in what is now the Firth of Thames and the Hauraki Plains; to the south the Hunua Hills form part of an uplifted block and it is possible that the islands, except Rangitoto and Motukorea, represent the northern end of this tilted block. The recent volcanism on the Auckland Isthmus has occurred on a down-thrown block to the north-west of the Hunua block.

It is probable that after these structural changes the Auckland area suffered no tectonic disturbances throughout the Ice Ages and into Recent times, and has been relatively stable. It follows then that during the last million years the history of the region must have been to a great extent dominated by the world-wide changes of sea-level resulting from the fluctuations in the intensity of glaciation associated with the Ice Ages. There has been a general but not constant lowering of sea-level since the Pliocene. Low levels during glaciations have

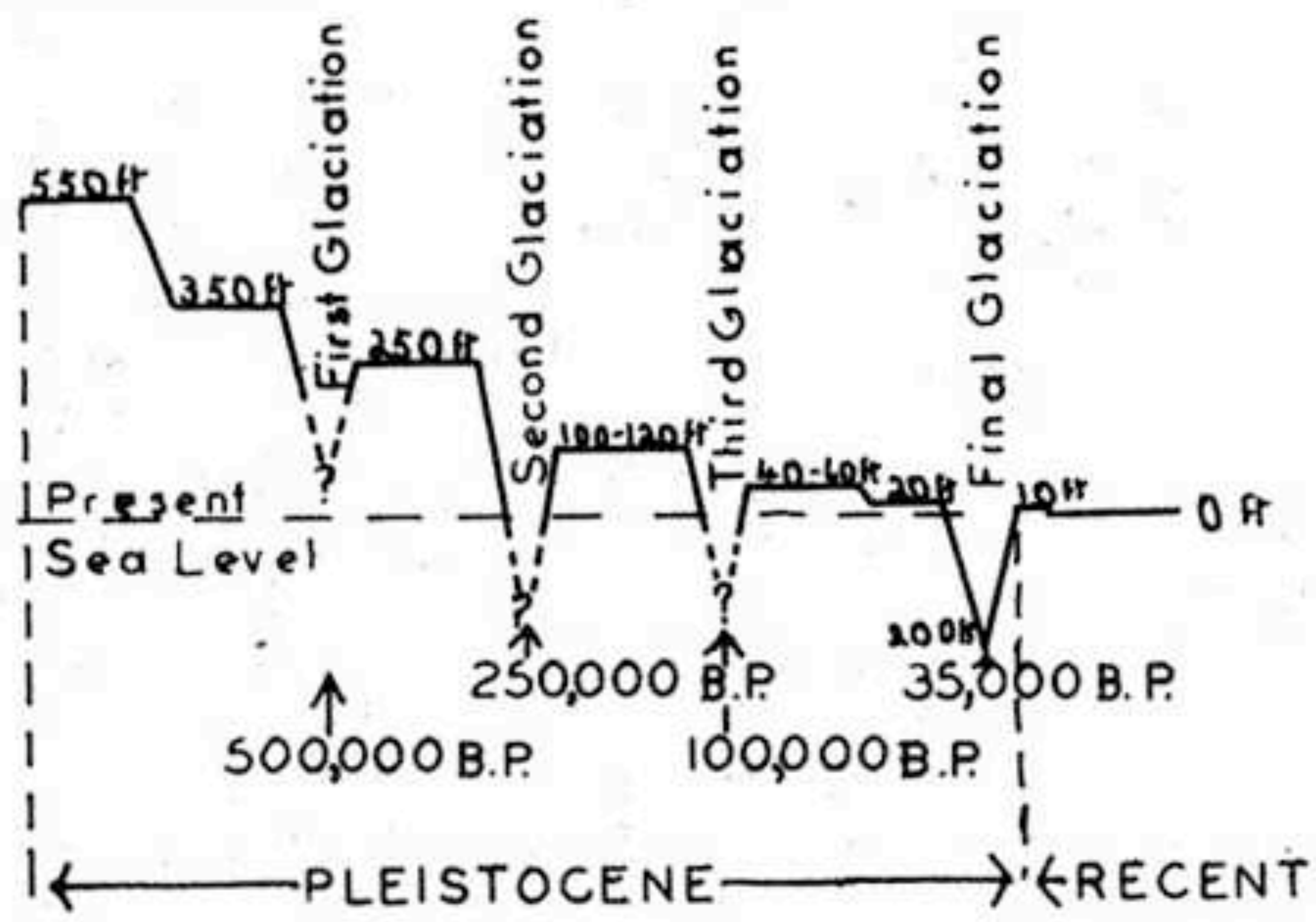

FIGURE 2.—*Graph of Relative Movements of Sea-Level during Pleistocene and Recent times with heights of terrace remnants as found around the Auckland Isthmus (from Searle, 1956).*

been followed by higher-level inter-glacials, with each inter-glacial level lower than the previous (Fig. 2). Still-stands of sea-level have allowed the carving or building of marine platforms and these are preserved today as marine terrace remnants at various heights above present sea-level. Little has been done on these remnants on the islands, but on the Waiheke coast there is evidence of terraces at 40-60 ft., 15-20 ft. and 6 ft., all of which have been formed since the 3rd glaciation (c. 100,000 B.P.). No terraces have been found on Motuihe. The Waiheke terrace remnants consist of raised beach and mudflat deposits with plant and shell debris, and fluvial gravels and silts without shells.

During the last glaciation, which reached its maximum about 35,000 B.P., sea-level stood over 200 ft. lower than at present and the Waitemata Harbour and Hauraki Gulf formed part of an extensive river valley system—the ancient Waitemata River (Fig. 3), which had existed for a considerable time and was responsible for the cutting of high-level terraces on the Isthmus. The sharp lowering of base-level however caused the river and its tributaries to become deeply entrenched in steep-walled valleys. It is not certain in what direction the river flowed once it reach North Head. It may have continued eastwards between the present mainland and Waiheke, but more likely it turned northwards and north-eastwards between Motutapu and Milford and out towards Great Barrier, being joined by tributaries from the Silverdale region. It is probable that the Ponui-Pakihi-Hunua ridge represented the eastern edge of the Waitemata River watershed at the time and that a major tributary, of which the present Wairoa River is a remnant, flowed westwards to join the Waitemata River near Rangitoto which was not then in existence.

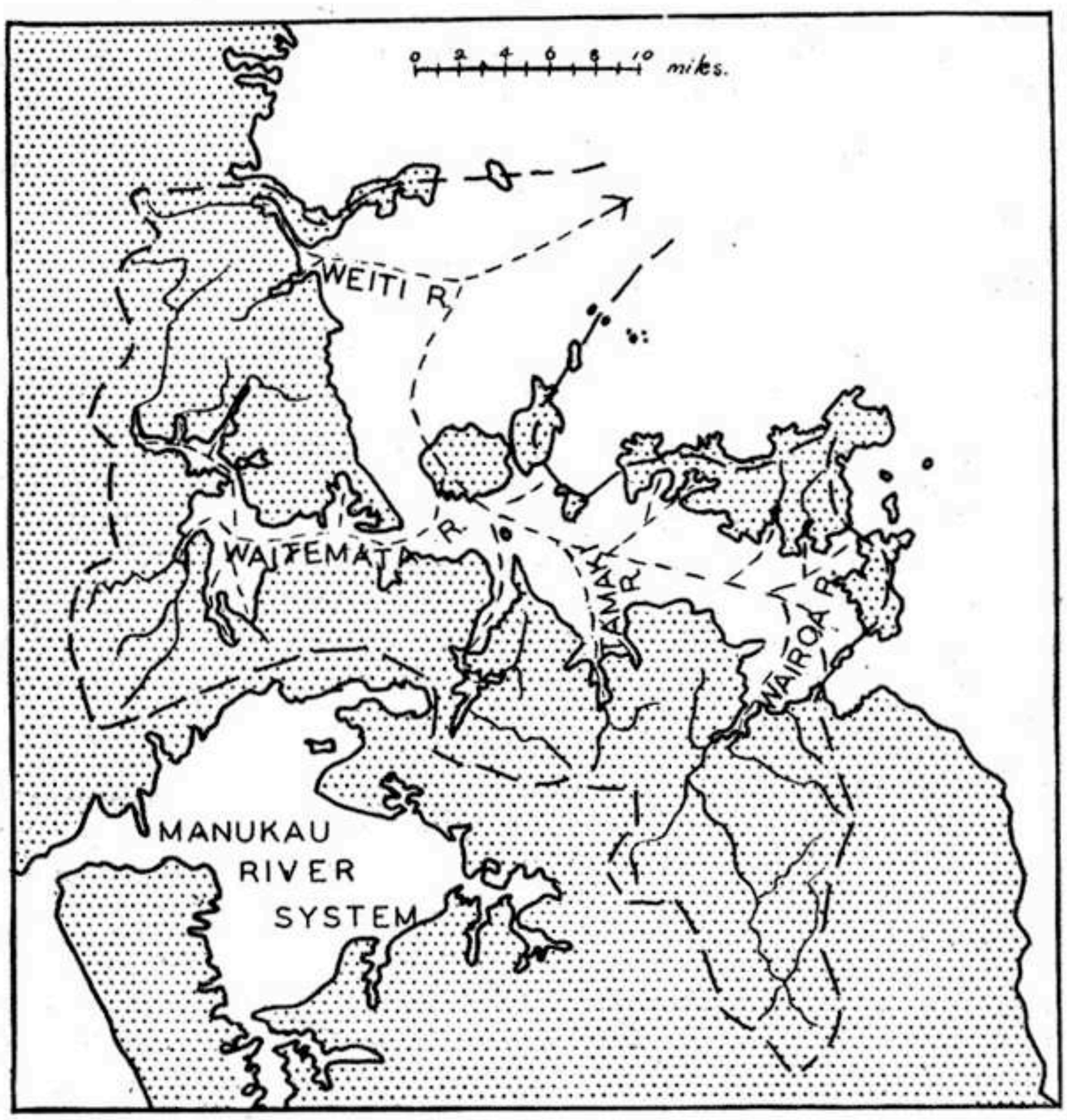

FIGURE 3.—*Hypothetical Reconstruction of Waitemata River System during last Glaciation (heavy dashes represent probable outline of watershed; light dashes represent drowned portion of river system; modern remnants shown in full lines).*

The end of this last glaciation, when sea-level began to rise as the ice melted, marks the beginning of the Recent Period. The sea invaded the river system and, probably 15-20,000 B.P., finally separated Waiheke, Motutapu, Ponui, etc., from the mainland. The drowned valleys became slowly silted up as sea-level continued to rise, ultimately reaching some 10 ft. higher than at present, with a subsequent drop after a period of still-stand, during which the present 10-12 ft. terrace remnants were built.

It was probably during the later stages of this transgression that basalt volcanic activity made itself manifest on the Isthmus, although the thin restricted lava flow in the north-eastern corner of Waiheke, may have been emplaced in the late Pleistocene. Recent volcanic activity on the islands of the Hauraki Gulf has been restricted to the western area and its products are Motukorea and Rangitoto, with a capping of Rangitoto Ash on Motutapu and Rakino.

Little is definitely known of the age of Motukorea, which is an eroded lava and scoria cone, but weathering features suggest that it is of a comparable age to many of the centres on the isthmus itself.

Rangitoto on the other hand is by far the youngest of the Auckland volcanoes. It consists of a wide lava apron surmounted by a group of cone remnants and a younger scoria and cinder cone. It has had quite a varied life with a number of phases involved. It probably began as a number of closely-associated vents producing scoria and cinders but little lava, and apparently no fine ash material was spread very far. At a later stage (and perhaps much later) a violent explosion left only the present remnants of the initial cones and spread ash over the surrounding area including especially Motutapu, where it fell still hot in a layer 2-3 ft. thick in the west and much thinner in the north. Perhaps almost simultaneously but maybe sometime later a circular fracture opened around this vent and a non-paroxysmal eruption of basaltic lava occurred forming the present gently-dipping apron.

The volcano ended its activity with feeble fire-fountaining to form the present summit cinder cone.

Brothers and Golson have produced further evidence of the island's activity from the study of a section on Motutapu through dune sands and ash beds. Almost at present sea-level they found ancient beach sands with no volcanic material, overlain by a layer of Rangitoto Ash. This bed, a primary ash originating directly from the eruption of the neighbouring volcano in its most violent period, is overlain by a series of dunes and lake beds up to the present dune surface. This shows there was only one major ash shower from Rangitoto. Shells in the beach sand beneath the ash and charred twigs from the base of the ash further inland gave a radiocarbon age of 750 $\pm$ 50 years B.P. which fixes the date of the explosion as occurring about 1200 A.D.

Evidence of human occupation of the island is found in all layers above the ash and this suggests that volcanic activity was rapidly over after the initial outburst. Since no ash is found covering the lava fields it must be assumed that extrusion of the lava postdated the eruption of the ash. It should be pointed out that the age of about 1200 A.D. dates the beginning of the ash eruption, and neither the beginning nor the end of activity on the island.

Topography

Mesozoic sandstones and argillites are the most extensive surface rocks in the area and the landscape developed on these beds is of a varied nature. Coastal sections are almost invariably steep and cliffed. (Here, the island of Pakihi, south of Ponui, is an exception, in having a fairly flat, low-lying central portion, this having resulted from more rapid erosion along a fault zone.) Further inland, where the rocks are more deeply weathered a rolling topography is produced. These rocks crop out around the southern shore of Motuihe, over much of Motutapu, and most of Waiheke, while Ponui, Pakihi, Pakatoa, Rotoroa, Rakino, and the Noises consist almost entirely of rocks of this group.

Waitemata Group sediments are less consolidated and cemented and the topography developed on them is more rolling, with slumping common in steeper portions. This is best seen on Motutapu and Motuihe, but small pockets also remain at the western end of Waiheke.

Since Quaternary sediments are raised beaches, alluvials, and bayhead fillings they underlie moderately flat surfaces. A notable exception is the ash covering of Motutapu which has blanketed the former topography and tended to smooth it out by being later washed and blown into the valley and flats sometimes forming dunes which have dammed valleys giving lake deposits.

Most of the information in this brief review is gleaned from the under-mentioned sources, with but little new material from the writer's own observation added. In addition, however, the author wishes to acknowledge the helpful discussions with Mr. E. J. Searle and Dr. R. N. Brothers of the University of Auckland, each of whom has carried out detailed surveys of portions of the Auckland area, and the help of Mr. J. C. Schofield, New Zealand Geological Survey, who prepared the geological map which was used on the New Zealand Ecological Society's excursion to the area.

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Soils of the Inner Islands of Hauraki Gulf

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Soils are of interest to students of ecology in two ways for not only do the soil conditions influence the flora and fauna of any particular area but in their turn the flora and fauna also modify the soils. This intimate inter-relationship merits ecological study.

The soils of the inner islands of Hauraki Gulf have not been examined in detail and what little is known of them was obtained from observations at some typical sites during a brief visit in 1940. The general survey of the soils of North Island summarises these observations together with additional information inferred from terrain in North Auckland with similar parent rocks and vegetation.

The soils of Motuihe, Waiheke, Ponui, and adjacent islets, illustrate well the zonal soils of the area (the northern yellow-brown earths and their podzolised counterparts) which are developed on freely draining relatively stable sites from ordinary siliceous rocks such as greywacke and mudstone.

Under the warm moist subtropic climate, the rocks weather rapidly to form clays leaving little weatherable material in the sand fraction. These clays, as they form, are leached during heavy rains, a process which is intensified or retarded according to the ability of the particular kind of vegetation to return nutrients to the topsoil in its leaf fall. In the younger soils, fertility is determined largely by the composition of the weathering parent rock, and deep rooting of vegetation is encouraged; as the soils become mature, the elements of fertility tend to be concentrated in a relatively thin topsoil while the subsoil becomes exceedingly impoverished and in consequence the vegetation tends to be more shallow rooted. With changing vegetation, such soils may degrade fairly rapidly but, having little or no reserve