SECTION E—CHAIRMAN'S ADDRESS

Pleistocene and Recent Deposits of New Zealand

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Summary

Overseas classification of glaciations was summarized and the importance stressed of establishing a rough order for New Zealand Pleistocene deposits.

It was considered that the following are the most important ways by which the relative age of glacial deposits can be determined:—

1. Superposition, when glacial beds are arranged in sequence.
2. Differences in elevation of terminal moraines and other glacial deposits
3. Differences in the degree of definition of fine glacial features
4. Differences in degree of weathering
5. Fossils, marine and non-marine
6. Radio-activity, in particular the proportion of C_{14} to C_{12}.
7. Tectonic features: degree of deformation and amount of faulting.

1. The first has proved particularly useful for distinguishing between the deposits of different glacial advances in continental regions where the deposits of each glaciation are thin In New Zealand, and in most regions of mountain glaciation, individual deposits are thick and the deposits of successive glaciations rarely occur in sequence. It seems likely that most of the glacial sections described from New Zealand are merely deposits of the last glaciation, and represent little time.
2. The second was used by Henderson (1931), high level deposits near Top House and Reefton were considered due to an early glaciation, and lower deposits to the last glaciation.
3. The third is useful when the rocks are of similar hardness, but it would be misleading to compare a granite with a mica-schist terrain, for fine glacial features, striae, etc., probably last ten times as long when cut in granite and gneiss than when cut in schist.
4. Up to the present little attention has been paid to weathering as indication of age by geologists in New Zealand. Although climatic differences will have to be considered, weathering is bound to be used to an increasing extent for determining the relative ages of moraines and river terrace deposits. In Nelson and Westland the gravel deposits of the last glaciation are distinctly more fertile than the gravels of the earlier glacial and interglacials which are mostly strongly podsolized " pakahis." At Charleston the higher and older " pakahis " are less fertile than the lower ones.
5. As the total length of Pleistocene time is only about a million years, few evolutionary changes are to be expected Fossils are however of particular importance as temperature indicators The mollusca have been so used by Fleming (1953) and the plants by Couper and McQueen (1954)
6. At least two different radio-active methods have been used The ratio of C_{14} to C_{12} is probably the most important. The half life of C_{14} is 5.600

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years and the method is useful for ages of the same order of magnitude. This limits the method to the very late Pleistocene and Recent.

7. Except in mobile regions tectonic changes during the Pleistocene are negligible. Part of the New Zealand region is extremely mobile and is intersected by parallel transcurrent faults that have shown slow movement at least since the middle Pleistocene. The relative ages of terraces can be determined when they happen to be interrupted by one of these active faults. It is important to consider the relation between inland terraces and glaciation, a relationship to which little attention has been paid hitherto in New Zealand. In the European Alps glacial outwash gravels were early recognised and formed the basis of Penck and Bruckner's classical scheme of four major glaciations. Glacial outwash terraces are well developed in many parts of the South Island, one of the clearest examples being at the head of Buller River a few miles downstream from Lake Rotoiti. Concentric terminal moraines around the lower end of the lake mark advances of the glacier. Streams flowed from the ice to build up the outwash terrace. The stream channels show clearly on air photographs. Both moraine and outwash terrace are considered to have formed during the last glaciation. The surface detail is still fresh but the Buller River has cut down through the outwash terrace by about 50ft. a few miles downstream from the lake. The Wairau Fault cuts across the lower end of Lake Rotoiti and has horizontally displaced by 160ft glacially modified features that are about the same age as the outwash terrace (Wellman, 1953)

The Canterbury Plain is considered to be a larger scale example of an outwash plain. A map was presented showing 100ft. contours on the plain and the morainic ridges described by Speight (1941). The relation between the plain and the moraine is considered to be the same as at Lake Rotoiti. The freshness of the surface detail and the degree of weathering suggests a last glacial age.

Differential displacement of Pleistocene terraces is best shown at Wairau Valley. There are three main deposits, each capped by a depositional surface:—

1. Top House gravels once filled the Wairau Valley but most have been eroded and only a few flat topped residuals now remain. They contain moraine at several places and are considered to mark an old glaciation.
2. Wairau gravels extend over almost the whole valley to form the Wairau surface. The Wairau gravels are fresh and similar to the outwash gravels of Buller River, and are considered to be of last glacial age. The present rivers have cut down through the Wairau gravels and at many places are flanked by a flight of terraces that leads up to the Wairau surface.
3 Recent deposits overlie the Wairau gravels from near Blenheim to the coast. The Wairau surface dips below the almost horizontal Recent deposits at an appreciable angle. The Recent deposits are composed mostly of sand and silt and are much finer than the Wairau gravel deposits.

Within the Wairau Valley and elsewhere in New Zealand *away from the coast* the glacials have been marked by the building up and the interglacials by the eroding away of alluvial deposits. During an early glaciation the Top House gravels were built up. in the following interglacial they were mostly cut down below the present level and only remnants left. During the last glaciation the Wairau gravels were built up to form the Wairau surface and during the present interglacial the rivers are again cutting down. Having shown the relation between the terrace-gravels and glaciations, it is now possible to get some idea of the relative ages of the glaciations by the amount the terrace surfaces have been displaced horizontally and vertically by the Wairau Fault near Branch River. The data already given by Wellman (1953) is summarized in the following table.

	Displacement		Inferred age
	Vertical.	Horizontal.	in years.
Top House Surface	250ft	?	250.000
post-Top House interglacial	?	c 2,000ft	100.000
Wairau Surface	10ft.	200ft	10,000

The inferred ages are not considered to be other than extremely approximate and are based on an age of 10,000 years for the Wairau Surface and for the last glaciation, and on the average rate of faulting being assumed uniform since the formation of the Top House Surface That the rate has been substantially uniform since the last glaciation is indicated by the direct proportion that exists between fault displacements and river downcutting at all the places where a transcurrent fault cuts across terrace flights that lead down from last glaciation aggradation terraces to the present rivers.

The tectonic evidence suggests two distinct glaciations at Wairau Valley, the early one being about 25 times as long ago as the last one. The early one is presumably the Penultimate glaciation.

Evidence for an early glaciation is less conclusive in other parts of New Zealand. Indication of a complex late glacial history is provided by the deposits between Waiho and Omoeroa Rivers in South Westland. A section exposed at Pug Creek, a tributary of the Omoeroa River, shows thin basal moraine overlain by marine silts and by peat that grew under present day climatic conditions. The peat is overlain by thick moraine that extends to the coast and forms part of the Peidmont sheet. At a height of 700ft and three miles inland an auriferous blacksand lead similar to those forming at the coast at the present day rests on a bench cut in the upper moraine. To the north, on the south side of the Waiho River valley, the Peidmont moraine has been smoothed by a late ice advance and a lateral moraine deposited. This late advance did not reach the blacksand lead or the Omoeroa River which flows in a non-glaciated valley except at its head. The following sequence of events is postulated —

Basal moraine Paringa advance	Early penultimate glacial
Peat layer climate as to-day	Interstadial ?
Thick moraine· Kinnaird advance	Late penultimate glacial
Rise in sea level	
Blacksand lead deposited	Last interglacial
Lowering of sea level by 700+ft (tectonic?)	
Lateral moraine Alpine advance	Last glacial
Retreat of glaciers to mountains	Post-glacial

Other deposits that may belong to early glaciations are: the high level fluvial-glacial deposits of Aorere Valley; high level gravels on valley shoulders in tributaries of Karamea River; huge boulders on high level terraces near Charleston, and the already mentioned high-level gravels of Top House and Reefton.

In conclusion diagrams were drawn showing how the reduction in the height of sea level during the last glaciation and the subsequent rise on the melting of the ice explains why the last glacial outwash deposits that were formed at a low sea level dip beneath Recent deposits that were formed at a sea level close to that of the present day.

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GENERAL SYMPOSIA (SECTION E)

1. *Geothermal Development.*
   See Section A.

2. *Radio-active Dating.*
   See Section A.

The following papers were also read:—

ALLAN, R. S. The principles of palaeo-geography.
BRADLEY, J. The environmental aspects of "greywacke".
BRODIE, J. W. The New Zealand continental shelf.
BROTHERS, R. N. Mineralogical and structural data on some Auckland greywackes
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COOMBS, D. S. The nature and alteration of some lower Mesozoic sediments from Southland and South Auckland.
COTTON, C. A. Periglacially modified landforms at Wellington.
COUPER, R. A. Fossil plants and Pleistocene and Recent Chronology.
FLEMING, C. A. Fossils and ages of some New Zealand greywackes
——— Report of Stratigraphic Nomenclature Committee.
——— Submarine features and palaeogeography.
GAGE, M. Age and origin of coal measures in N.E. Otago.
——— Chronology of glaciations in New Zealand.
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GRINDLEY, G. W. Significance of Upper Palaeozoic facies changes. West Otago, and origin of peridotite bodies.
GUDEX, M. C. "Manawa wood" of the Waikato swamps
KEAR, D Age significance of eroded volcanic forms
——— Pumice Chronology in New Zealand
——— Tertiary palaeogeography of South Auckland
MASON, B. H. and LILLIE, A. R Solid geology of the country between Hooker Glacier and the Alpine Fault.
MUTCH, A. R. The Upper Palaeozoic stratigraphy of the Takitimu Mountains
N.Z. GEOLOGICAL SURVEY. Palaeogeographical maps of New Zealand from the Cretaceous to Recent.
PULLAR, W. A. Sedimentation on the Gisborne Plain since the Gisborne ash shower
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SCHOFIELD, J. C. Vulcanism and structure of the southern portion of the Hauraki Graben
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WOOD, B L. The Fjordland complex.