THE MOUNTAINS AND GLACIERS OF NEW ZEALAND*

By N. E. Odell

In this lecture an outline was first given of the principal topographical features and geological formations of the country, with particular reference to the greater mountain ranges and groups, and to what is so far known of their structure and tectonics. New Zealand is a very mountainous country, in all three of its main islands, and geologically it is very young: this is markedly shown throughout in its scenery. Only a million years ago a large part of the North Island was under the sea, as well as certain areas of the South Island; and 60 million years ago (Lower Eocene times) most of the present land-area of New Zealand was submerged.[1] There is evidence that the geological history of New Zealand has been one of almost continuous, and intense, tectonic activity, which is in contrast with most of the continental regions of the world. While the present volcanoes of the North Island are a Recent, or Pleistocene, feature, there appears, from the succession of earlier strata in many parts of the country, to have been repeated volcanic action in the past. But no volcanic rocks have been found throughout the full extent of 250 miles (400 km.) of the Southern Alps, which form the eccentric backbone of the South Island; nor significantly, and unlike so many other great ranges of the earth, are there within the Alpine zone intrusive masses of igneous rocks.

The Southern Alps, with such high peaks as Mounts Cook (12,349 ft., 3,765 m.), Tasman (11,475 ft., 3,500 m.), Sefton (10,359 ft., 3,160 m.), Aspiring (9,957 ft., 3,040 m.) and others, are essentially an uplifted block of Mesozoic sedimentary rocks with a narrow belt of schists along its north-west side, adjacent to the great Alpine Fault. The latter is a major structural and tectonic feature, whose transverse, as well as overthrust, movements have been continuing until the present day, and directly influencing the elevation of the Alps. The volcanic *massif* of the North Island is in great contrast, with its highest summits, and presently or recently active centres, of Mounts Ruapehu (9,175 ft., 2,795 m.), Ngauruhoe (7,515 ft., 2,290 m.) and Tongariro (6,517 ft., 1,986 m.). These border to the north-east a great area of hill-country, which was covered by earlier pumice-showers, ejected from vents now submerged in Lake Taupo, with its important hydro-thermal district nearby. The region lies at the intersection of the two main crustal fold-systems of the North Island, and is therefore of great structural significance. The satellite centre of Mount Egmont (8,260 ft., 2,518 m.), lying some 80 miles (130 km.) distant on the coast to the west, is a beautiful symmetrical volcanic cone of similar Quaternary age.

With regard to the existing glaciers, in the North Island it is only on Mount Ruapehu that there are found restricted *névé* masses;[2] and these have been greatly diminished in volume in recent years.[3] There is erosive evidence that during the Pleistocene epoch glaciers descended to at least 6,000 ft. (1,830 m.). This, however, does not seem to have been the minimum altitude. The regional snow-line now stands at about 8,200 ft. (2,450 m.), whereas in Pleistocene times it appears to have been depressed to about 4,400 ft. (1,340 m.).[4] These figures are about 1,000 ft. (305 m.) higher in each case than those for the Mount Cook district in the South Island, corresponding with a difference in latitude of 3° 16′. It is well known that in the vicinity of Mt. Cook are located New Zealand's most extensive glaciers, the longest being the Tasman Glacier of about 18 miles (29 km.). Some account of these glaciers was given, and a reference made to the early observations and measurements of Brodrick and Baker in the 1880's and 1890's, as to the changes in surface, front and margins of the Tasman, Hooker and Mueller Glaciers in particular; of Douglas and Harper, Speight and Bell in the case of the Franz Josef and Fox Glaciers. Sundry observations by Harrington and by the

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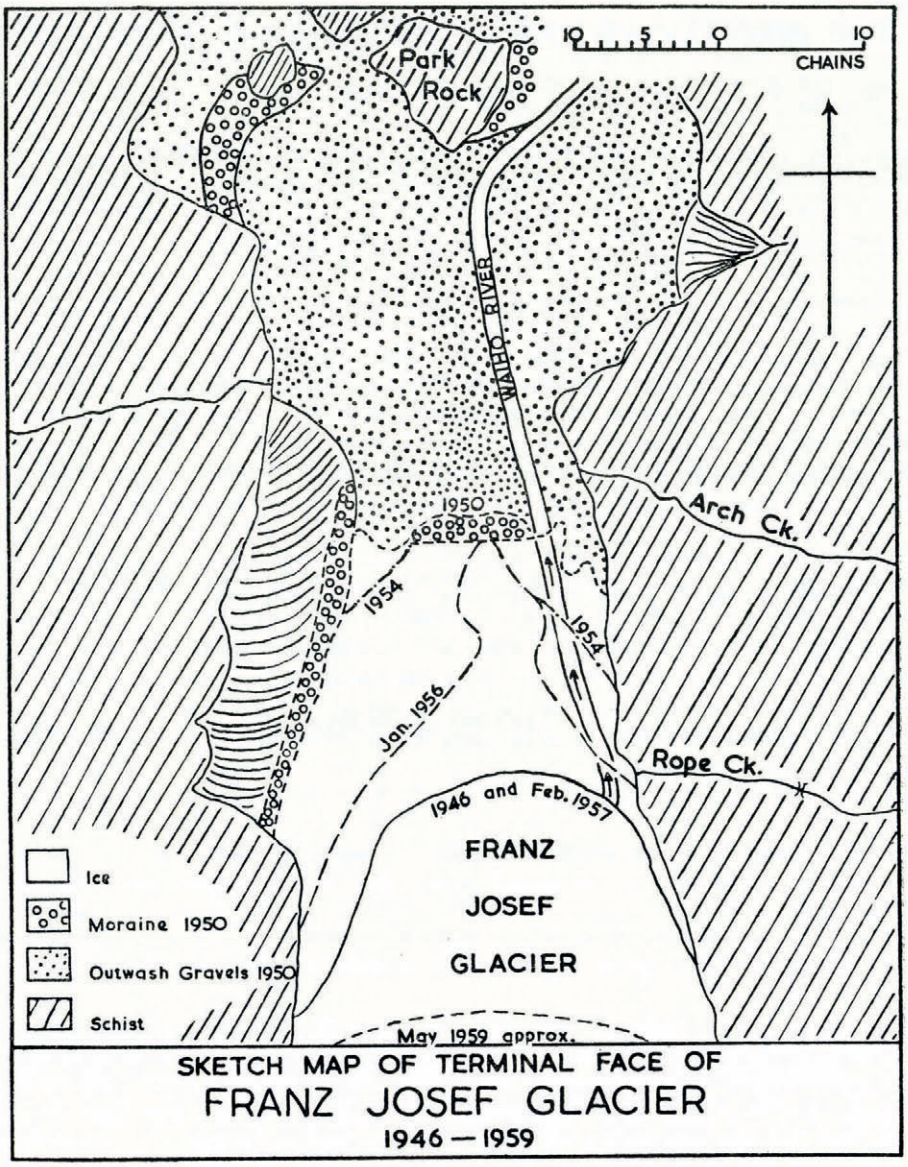

lecturer between 1950 and 1955 confirmed the progressive changes mainly of retreat and surface-wasting that have taken place over the years. The lower six miles of the Tasman Glacier are now covered by a vast undulating blanket of ablation moraine, a veritable "*Felsenmeer*". An item of some interest, photographed from the air in 1953 (Fig. 2, p. 743), were curious circular features in this "*Felsenmeer*" below the junction with the Murchison Glacier valley. Later examination on the ground was inconclusive in respect of their having originally been circular crevasses, of the type recorded in the Coast Range, B.C.,[5] or alternatively due to some kind of localized sub-glacial collapse, or "block-caving", as reported from the Alaska Range.[6] After many years of neglect it was gratifying to record that the N.Z.

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Geological Survey, under the aegis of the I.G.Y. programme, has lately instituted a series of glaciological measurements on the Tasman Glacier, with a view to the determination of its regimen, etc. Its motion has been recently shown by McKellar and his party to average 1·12 ft. (0·341 m.) per day over the late winter period in 1957, and 1·45 ft. (0·442 m.) per day over the summer period, opposite the Malte Brun hut.[7] A seismic cross-section was also to have been carried out during the current Southern summer (1958-59), which should definitely correct the exaggerated depth of ice of 1,200 ft. (366 m.) and more opposite the Ball hut, claimed to have been determined under Admiral Byrd's auspices when he was *en route* to the Antarctic many years ago. In Westland the Franz Josef Glacier has received perhaps more attention than any other, in view of its accessibility (it descends to an altitude of about 700 ft., 213 m.), its grandeur and the remarkable changes in the position of its front over the years. Falling from *névé* to snout at a gradient of about 1,064 ft. per mile (200 m. per kilometre),[8] it displays, when in periodic advance, marked overthrusting at its terminal front. Its maximum daily movement in the middle reach was determined in 1893 to be about 12 ft. (3·66 m.). This, however, is rather more than twice the average rate also found by Harper and Douglas. In comparison, a recent estimate of average flow was made by the present lecturer in 1955, by observing the distance travelled down the glacier by a wrecked aircraft between March 1950 and January 1955. This was computed as 5 to 6 ft. (1·52 to 1·83 m.) per day.[9] So there would appear to have been little or no change in the general rate of flow in recent decades. Changes in the glacier front have been recorded by Suggate [10] and others, and the systematic taking of photographs from a fixed station has been organized from 1951 onwards. In the case of the Fox Glacier, southern Westland, which has consistently been in retreat in recent years, the lecturer reported that he was able to make scattered observations, including some on an interesting series of dust-layers, of Australian desert, or alternatively South American volcanic, origin.

Many lantern-slides and maps were shown to illustrate the above features, as well as the varying aspects of the country from Milford Sound, north-eastwards through the Southern Alps, to the volcanoes of the North Island, with sundry comments, for the mountaineers present, on climbing achievements, particularly in the Mount Cook district. Mr. H. E. L. Porter kindly lent some slides from his large collection of this district, for the purposes of the lecture.

Some of the photographs shown are reproduced on p. 743-44.

MS. received 5 May 1959

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We append a note on the fluctuations of the Franz Josef Glacier by Mr. F. E. Bowen. Professor Odell was without knowledge of this note at the time he prepared the report printed above.—*Ed.*

Advances and Retreats of the Franz Josef Glacier

Since the discovery of the Franz Josef Glacier the ice has increased and diminished in volume several times with consequent advance and retreat of the snout of the glacier. Records over the past 90 years show slow, steady retreat until 1910, followed by rather quicker retreat until 1921 by which time the glacier had gone back a distance of about 300 yards (275 m.). Between 1921 and 1933 the glacier advanced, the position of the snout in 1933 being about 150 yards beyond the 1921 position. This was followed by a rapid retreat and by 1946 the glacier was about three-quarters of a mile (1·2 km.) back from its position 75 years earlier.

A rapid advance, followed in early 1950 by a slower advance which continued until October 1950, then pushed the snout forward 350 yards from the 1946 minimum. The ice, both at the snout and higher up the glacier, then began slowly to waste, the rate on the moraine-covered terminus being slower than on the uncovered ice further back. This slow wasting continued until 1955 but late in that year and in the first few months of 1956, a series of floods washed away much of the ice and moraine forming the terminus, leaving a remnant separated from the new ice front.

The snout of the glacier has since retreated to approximately the 1946 position and the level of ice on the glacier itself is much below that for many years past. In front of the snout pools of water, many of them circular, are separated by ridges of moraine-covered ice. The large scree which abutted against the west side of the glacier in 1950, is now isolated and being destroyed. In many places the debris has slid into the valley, showing old ice beneath. The river now emerges from the eastern side of the snout, flowing across the gravels and to the east of Park Rock. Old channels abound in front of the ice, attesting to the many recent changes in the course of the river after leaving the glacier.

From past experience it may be expected that the ice will advance again, but for the moment there is no sign of this happening. It appears probable that the retreat of the glacier will continue for some time to come.

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Fig. 1. Franz Josef Glacier, c. 1867. A. P. Harper[8] states that in 1867 the ice reached the top of Sentinel Rock on extreme right. Photograph by H. Pringle

Fig. 2. Unexplained circular surface markings in lower reach of Tasman Glacier. Vertical photograph at 10,600 ft. (3,230 m.) by R.N.Z.A.F., 31 March 1953

Fig. 3. Franz Josef Glacier, May 1959. Shows extensive outwash plain and former trim lines. Photograph by W. A. Sara

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Fig. 4. Fox Glacier, 1954 or 1955. Douglas Peak, 10,107 ft. (3,080 m.), at head of glacier

Fig. 5. Shrinking snout of Fox Glacier, 1955

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