SOME SLUMPS AND BOULDER FIELDS NEAR WHITEHALL

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SUMMARY

Cotton's statement, that stream erosion is mainly responsible for the fine-textured relief of the greywacke ranges of New Zealand, and Lauder's statement, that present-day erosion causes only moderate modification of the New Zealand lanscape, are questioned. Field evidence suggests that non-periodic mass movement is largely responsible for the detailed sculpture of greywacke ranges of South Auckland. Some of these movements can be approximately dated by the presence of volcanic ash and lapilli in or on the mass movement deposits. It is concluded that deep weathering, which may be of interglacial age, and non-periodic intense rainfalls are primarily responsible for the conditions which induce mass movement.

INTRODUCTION

Recent papers by Cotton (1958a, b; 1962; 1963a, b) and Mortensen (1959) state that stream erosion is responsible for the fine-textured relief of much of the hill country of New Zealand. Lauder (1964) suggests that little erosion is currently occurring . . . 'the permanence of superficial, soft, glacial and volcanic deposits on relatively steep slopes and the existence of a fine-textured, dry drainage pattern in many parts of New Zealand seem to indicate that present-day erosion causes only moderate modification of our landscape' . . . and . . . 'there has been only moderate modification of our landscape, in the last 10,000 or even 100,000 years' . . . state the case clearly. The remarks of these workers, however, seem to be applied mainly to the greywacke ranges of the southern part of the North Island and the northern part of the South Island, which have been affected by periglacial climatic regimes during the Pleistocene period. The greywacke ranges of the northern part of the North Island have probably not been so affected — Willett (1950) — and it seems desirable to investigate the erosion processes which have been and are responsible for their

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fine-textured relief. Extensive field work in the Hunua, Hapuakohe and Raglan hill country suggested that the area around Whitehall (N.Z.M.S.1 sheet N66) would provide features characteristic of the South Auckland ranges which could be approximately dated by the presence of mantles of volcanic ash.

STUDY AREA

The area chosen for detailed study is located about three miles north east of Whitehall at grid reference 110385 on a south-west-facing slope (Figs. 1 & 2). The tops of the ridges are at an altitude of about 1,250 ft. a.s.l. and the floor of the main valley is at about 700 ft. a.s.l. The hills are composed of indurated greywacke (Mead, 1938) which has a deep weathering mantle exposed to a depth of about 9 ft. in a cutting 400 yards from the study area (at G.R. 114372).

Major features of the slopes are: the large amphitheatre-shaped scars left by mass movements occurring mainly near the crests of the slopes, but also on the sides of the spurs; the boulder fields which occupy many of the amphitheatres; and the valley floors which in some areas are infilled by fine sediments, and in other parts are being eroded by slightly incised streams.

MASS MOVEMENT

The mass movement forms are of three main types: (1) large amphitheatre features occurring near the slope crests; (2) minor amphitheatres which may occur at almost any position on the slopes; (3) crescentic shallow scars.

The large amphitheatres are represented in Fig. 1 by features M, L and F. They have mean dimensions of about 600 x 400 feet and are between 80 and 30 feet deep. M and L have relatively flat floors, gently sloping — 7° and 5° — towards the main valley. The floors are strewn with boulders. F is a similar feature except that its floor has a mound of boulders and fine earth which is shown in the long and cross profiles (Fig. 3). The whole study area was once in forest which was removed in the 1890s when grassland was established. The land then reverted to bracken and scrub, which was burnt off in the late 1930s. Since 1945 all of the slopes of less than about 20° have been cultivated by giant discs, and some ridges have been smoothed by bulldozing. The walls of the amphitheatres have been considerably smoothed and modified by cultivation, but the boulder-strewn surfaces are largely unaffected and decaying tree trunks are still to be found on them.

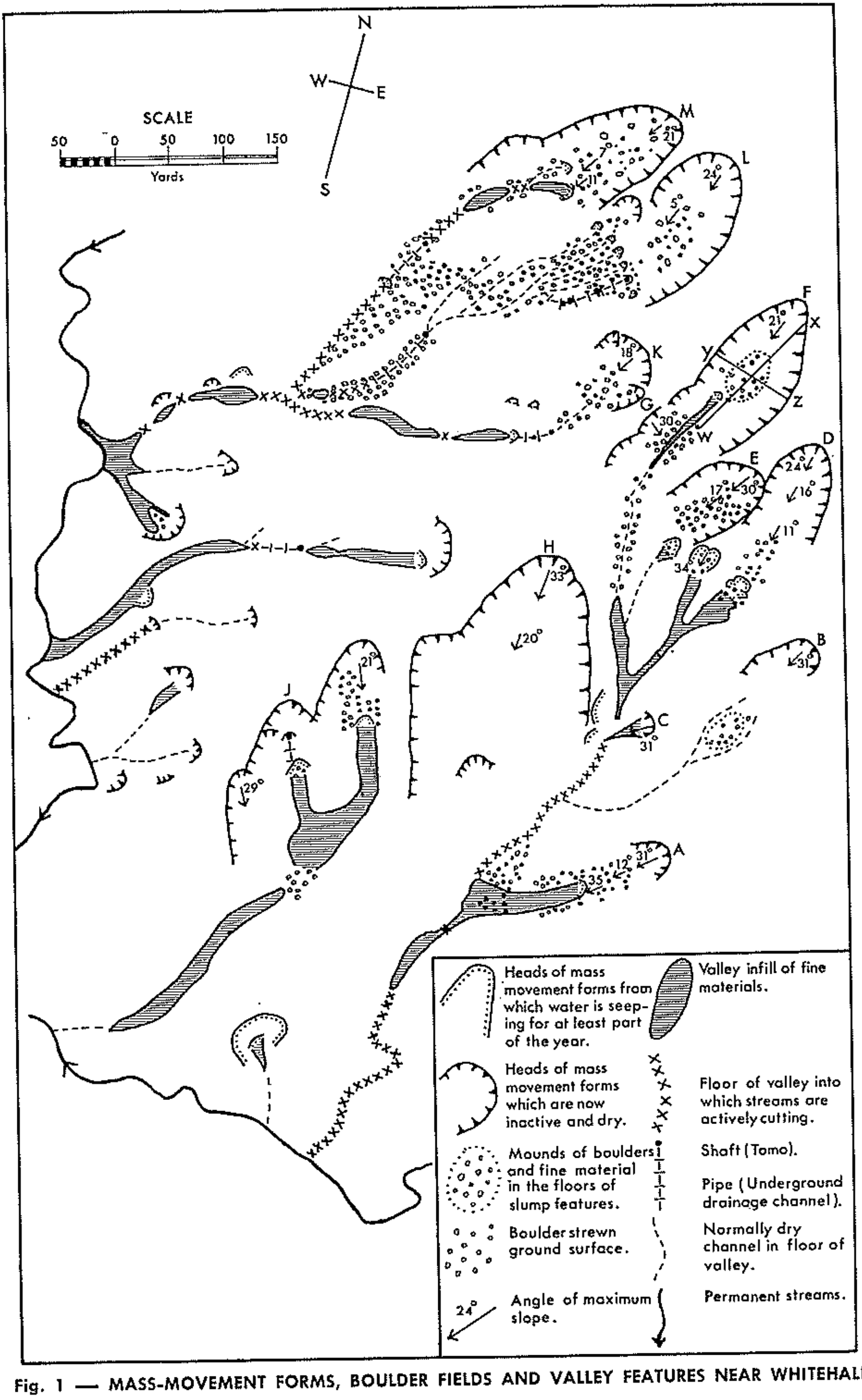

Fig. 1 — MASS-MOVEMENT FORMS, BOULDER FIELDS AND VALLEY FEATURES NEAR WHITEHALL.

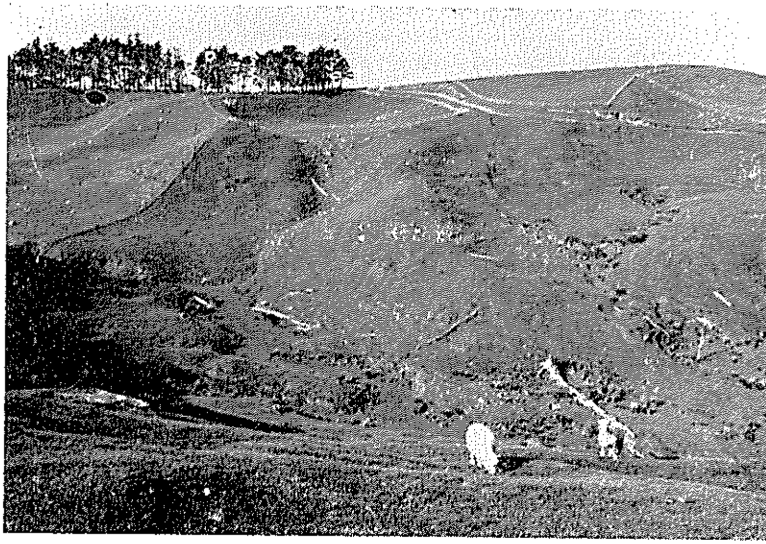

Fig. 2 — A DEEP SLUMP SCAR is visible just below the right-hand end of the line of trees. Boulders litter the surface beneath its outlet and the valley below it is infilled by fine sediment.

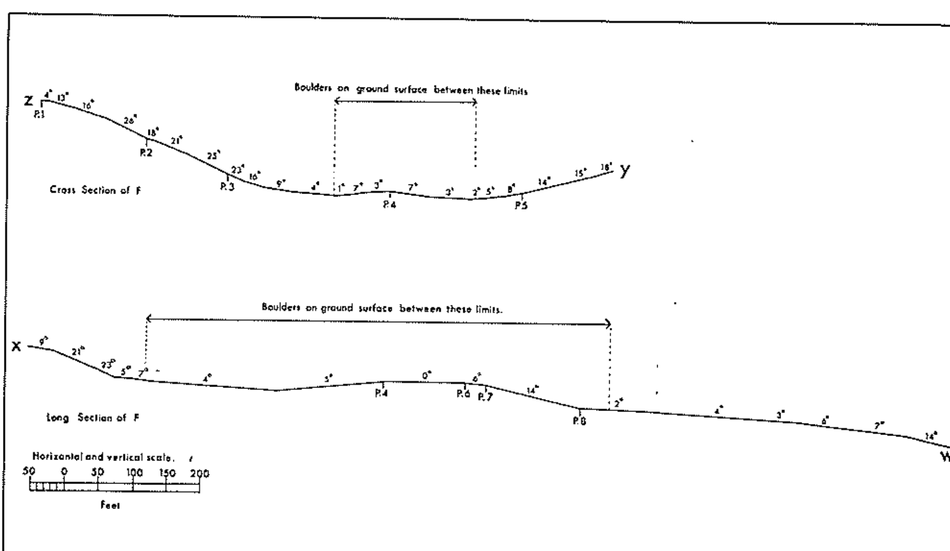

Fig. 3 — PROFILES across and along the amphitheatre F (See Fig. 1).

The large amphitheatres do not contain permanent water or channels but are drained by springs which emerge at small seepage heads along the lower margins of the amphitheatres.

The minor amphitheatres vary in size but B and K, which are only about 100 x 100 ft. and 10 ft. deep, are about the maximum size. They occur at any position on the slope except near the crest. They are of three types: (1) those with dry boulder-strewn floors; (2) those with dry smooth floors; or (3) those with floors drained by spring seepages. The possible combinations occur at J.

The third type of feature is a steep-angled — 20° or more — feature with a headward scar and steep, flat floor. It is illustrated by H (Fig. 1), which is by far the largest of this type.

BOULDER FIELDS

'Boulder fields' is a non-genetic term used to denote large masses of boulders irregularly distributed over the ground surface (King, 1966). In the study area the boulders occur in the floors of the amphitheatres, and in the valleys below them (Fig. 4). Their distribution is shown in Fig. 1. The boulders vary in size from a maximum of 3 x 4 x 3 feet. Nearly all are rounded and a study of a 10% sample in three amphitheatres — M, L, F — indicated that they are not preferentially oriented or sorted. The boulders have only thin weathering skins — usually less than ¼ inch — and when struck with a hammer break with a concoidal fracture into smaller rounded forms by the spalling off of fragments. In all of the boulder fields grass is established on the fine material between individual boulders.

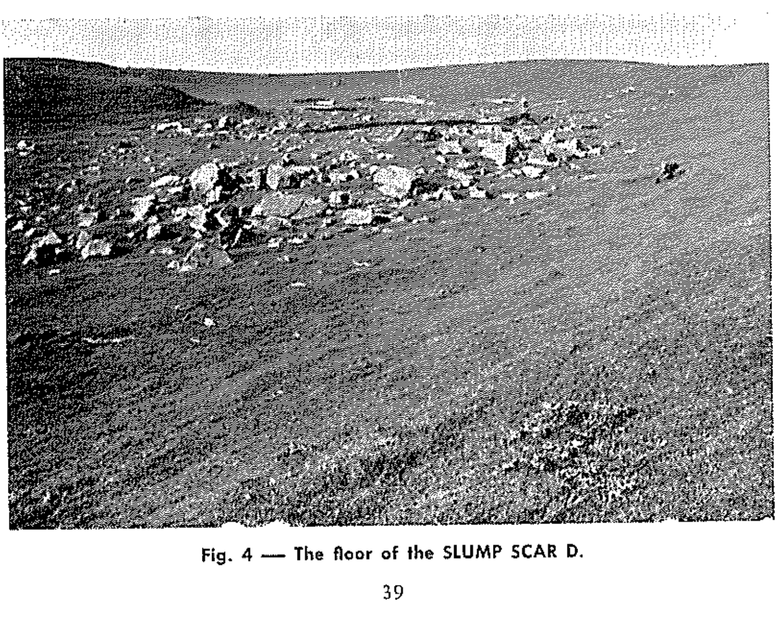

Fig. 4 — The floor of the SLUMP SCAR D.

VALLEY FLOORS

The main valleys have permanent streams with clearly-defined channels. The minor valleys, however, have a variety of forms although all head in mass movement scars. Some of the minor valleys have no stream channels in them and are merely broad elongated depressions, but some do have channels and others have flat floors which are infilled by fine sediments. Augering across the infilled valley floors suggests that the valleys once had a U or V-shaped cross profiles which have been modified by depositions of reworked colluvium. Water in the valleys is derived from springs in seepage heads. This water either flows over the grassed surface of the flat infill without breaking through the turf to form a channel, or flows beneath the infill in natural pipes. Some sections of the pipes have collapsed to form shafts — locally known as tomos — and other shafts occur within minor mass movement scars — as below L (Fig. 1).

ASH DEPOSITS AND THE REGOLITH

The sequence of ashes on the slopes, and the nature of the regolith is best described by reference to the cutting at G.R. 114372. In the deepest part of the cutting are exposed three clearly-defined ash deposits surmounting deeply red-weathered greywacke. The details of the profile, from the top downwards, are:

0 - 14 in. Dark A-horizon material containing pumice lapilli recognizably from the Taupo eruption (1900 ± 60 B.P.*).

14 - 36 in. Yellow Rotoma ash (this is more than 3270 ±200 B.P. but less than 8850 ±100 B.P.).

36 - 73 in. Yellow-brown Rotorua ash (between 8850 and 15,000 B.P.).

73 - 109 in. An older brown ash, which has not been identified but which is easily distinguishable from the younger ashes.

109 - 121 in. Light yellow colluvial material containing small boulders of greywacke.

121 - 127 in. Grey-yellow banded ash deposit which may be the Rotoehu ash (35,000 B.P.).

127 - 140 in. Red-weathered colluvium.

140 in. A shaved surface which may represent the slip plane of an ancient mass-movement feature.

140 - ? in. At least 9 ft. of red-weathered greywacke containing resistant core stones produced by spheroidal weathering. The core stones are up to 1 cu. ft. in volume and have several weathering skins which can be easily broken off to leave a relatively unweathered greywacke boulder.

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* All dates are from Healy, Vucetich and Pullar (1964) and are reckoned from 1950 A.D.

That the features in the cutting are typical of the area is shown by numerous exposures in a roadcutting running up a valley within 300 yds. of the study area, and by 20 profiles dug in the amphitheatres and slopes. In the amphitheatres a typical profile dug on an uncultivated site (see P4 in Fig. 3) is:

0 - 1½ in. Medium brown grass root mat.
1½ - 6 in. Dark brown granular structures containing humus-stained Taupo pumice lapilli up to ½ inch long.
6 - 14 in. Yellow-brown humus-stained mixture of Rotoma and Rotorua ash with weathered greywacke.
14 - ? in. Light yellow ash and greywacke containing small rounded boulders of weathered greywacke.

Auger data from the uncultivated ridge tops and valley sides also indicates that the Taupo pumice lapilli occurs as a thin mantle over the Rotoma and Rotorua ashes, even where these older ashes have been mixed with weathered greywacke in the amphitheatres.

GENESIS OF THE LANDFORMS

An attempt has been made in Fig. 5 to indicate how these landforms have been formed. It is assumed that the main valley has been cut by a stream which may have been assisted by mass movement. The minor valleys show virtually no sign of stream erosion and are thought to have been formed by mass movements. The present land surface indicates that this is of two main types. On many of the steep slopes large debris slides with no rotational movement occur. Examples are found at H and J. Sharpe (1938) defines a debris slide as a . . . 'movement of predominantly unconsolidated and incoherent earth and debris in which the mass does not show backward rotation but slides or rolls forward' (p.74). He states that it involves 'rapid' movement but there is no indication in the study area of the rate of the process although Sharpe's figure (p. 67) illustrates the type of feature which occurs at H. The second type of mass movement is a slump, defined by Sharpe as 'the downward slipping of a mass of rock or unconsolidated material of any size, moving as a unit or as several subsidiary units, usually with a backward rotation' (p.65). Evidence of the rotational movement is present in the forms of the mounds of boulders and ash in the ampitheatres B and F.

The floors of the minor valleys are infilled with redeposited fine ash and weathered greywacke, which has been washed out of the mass movement debris. This mass movement must have occurred between 15,000 B.P. and 1900 B.P. because the Rotorua and Rotoma ashes are mixed with the other debris, and the Taupo lapilli mantles all of the slopes and mass movement scars and debris.

The boulder fields occur where the mass movement was of the deep rotational type. It is suggested that the boulders were

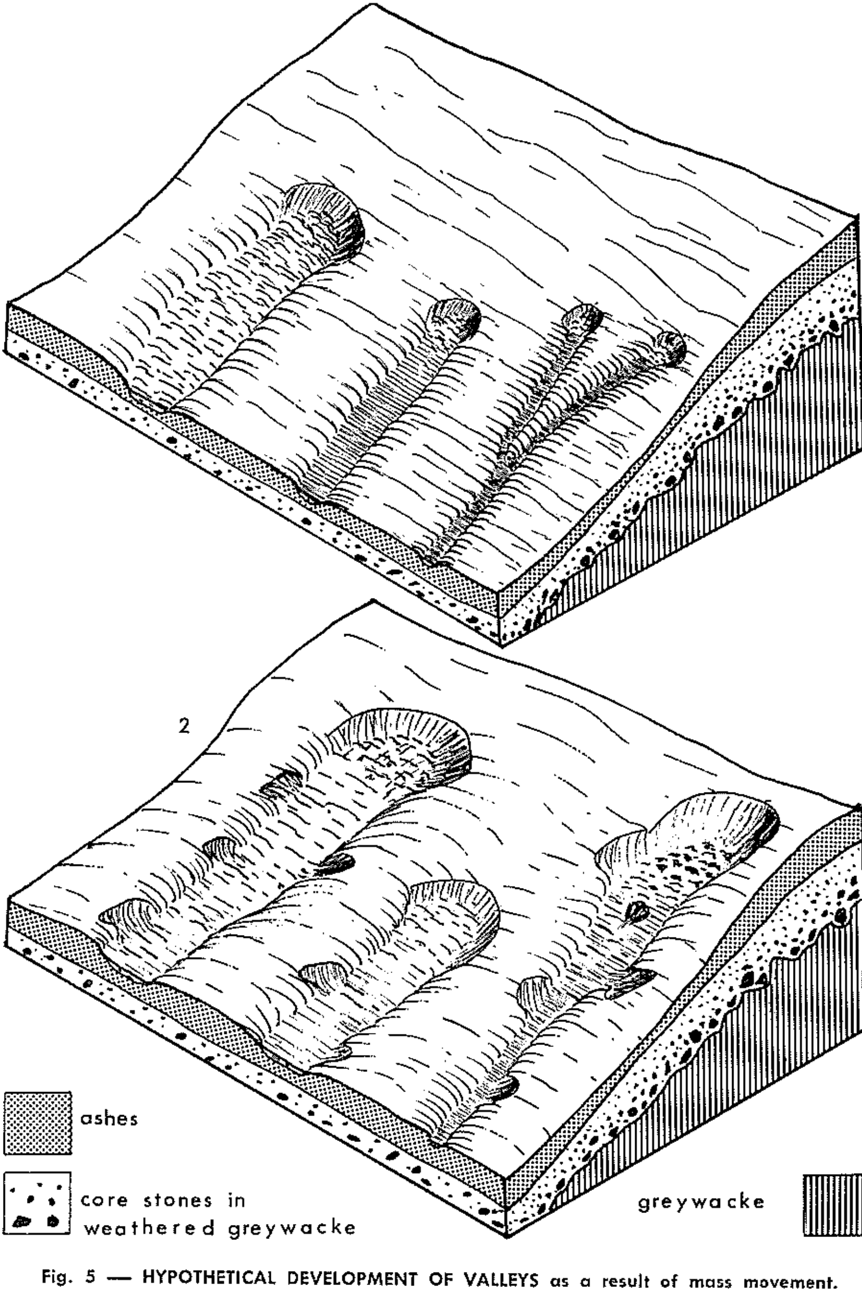

Fig. 5 — HYPOTHETICAL DEVELOPMENT OF VALLEYS as a result of mass movement.

core stones which were stripped of their weak weathering skins during the mass movement, and which show no preferential orientation because the distance they moved was too small — this is in contrast with the boulders described by Lundqvist (1949) and others. The fine ash and weathered greywackes have been partly removed from between the boulders and have infilled the valleys. Most of this removal must have occurred before 1900 B.P. because the Taupo lapilli mantles the floors of the amphitheatres.

CONCLUSIONS

Field evidence suggests that Cotton's statement, 'Relief of fine texture due to sculpture by streams of running water is characteristic of New Zealand' (1958a, p.187) has to be modified to include mass movement. Lauder's suggestion that . . . 'there has been only moderate modification of our landscape in the last 10,000 or even 100,000 years' . . . likewise has to be modified, for although most slopes have been unaffected by erosion — as shown by mantles of Taupo lapilli — during the last 1900 years so that general lowering of the land surface is negligible, periods of intense local mass movement are a feature of processes on the greywacke ranges of the northern North Island. The evidence from the study area, the events during March 1964 in the forested Kahikitia Range (Jones, 1964), the work by Grant in the Ruahine Range (1965) and the numerous mass movements in the Hunua and Hapuakohe Ranges in February 1966 all attest the past and continuing importance of non-periodic geomorphic events of an instantaneous kind. There is thus no need to invoke periods of different climate to acconut for the present-day landscape. The deep weathering and fine matrix of the boulder fields indicate that periglacial activity is not significant in the formation of the land surface of the study area. In this respect the South Auckland district has features more akin to those described by Berry and Ruxton (1961) in Hongkong than those of Wellington described by Cotton and Te Punga (1955), and Stevens (1957). Furthermore, the boulder fields are more like those described by Demek (1964) and Rother (1965) and ascribed to Tertiary deep weathering, than to the periglacially-formed features described by Smith (1950), Joyce (1950) and King and Hirst (1964). There is, however, no evidence that the Whitehall boulders were produced in the Tertiary Era, and they might well be the result of interglacial weathering. The outstanding feature of the northern greywacke ranges is the incompetence of contemporary stream erosion and the significance of mass movement.

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