

ART. LV.—Notes on the Earthquake of the 24th June, 1891.

By GEORGE HOGBEN, M.A.

[Read before the Philosophical Institute of Canterbury, 4th November, 1891.]

Plate XXXIX.

THIS earthquake is one of the most considerable recorded in the Auckland District; but there is some difficulty in arriving at a definite conclusion in regard to the origin. Nevertheless, the facts of the earthquake, and some attempt at an explanation of them, should, I think, be placed on record. The data, obtained through the Telegraph Department, are given in the accompanying table (pp. 575, 576).

1. For the determination of the epicentrum the usual time-methods were employed. Assuming all the times to relate to the same shock, by the method of circles, with velocity twelve miles per minute, we obtain from the times at Auckland, Cambridge, Thames, and Tauranga an epicentrum E, about twelve miles south of Mercer; but this does not agree with the time at Mercer (probably a good observation), nor with that at Helensville. By taking a point F, about twenty miles southwest of E, and a slightly greater velocity, we may make our solution suit Mercer better, but Thames hardly so well; it would agree with the effects observed at Raglan. The normal equations derived from the equations of observation (see Trans., vol. xxiii., p. 476) give N for the epicentrum; but, though this may give the mean position of the epicentra of several shocks near together in time, it does not agree closely with any of the data. None of these three points—E, F, N—agree with the times at Wanganui (a good observation) and New Plymouth (doubtful). The investigations, however, lead us to suspect two shocks following one another at a brief interval, the first proceeding from below some point within the circle whose centre is A, and the second (and chief shock) from below the circle whose centre is B.

2. I next tried to arrive at some conclusion by considering the intensity of the shock at various places. For this method of working I am indebted to a paper on the "British Earthquakes of 1889," by Charles Davison, of Birmingham (*Geological Magazine*, 1891). The dotted lines on the map (Pl. XXXIX.) show the isoseismals (lines drawn through places at which the intensity was the same): the intensity has been marked on the Rossi-Forel scale. The intensity of the shock was greatest within the innermost curve, the area marked VII. to VIII. on the map. The shaded portion shows the area

Place.	Time of Beginning of Shock. (N.Z.M.T.)	Nature of Shock.	Apparent Direction.	Apparent Duration.	Effects.	Remarks.
New Plymouth III.	A.M. 10.50	Slight ..	N.E. to S.W.	10 secs.		
Mercer VII.	10.52*	Sharp ..	S.E. to N.W.	2 secs...	A chimney partly shaken down. Cups swung on hooks for some time after shock. Horses alarmed	No previous tremor or warning.
Thames III. to IV.	10.53*	Sharp; two shocks	N. and S.	About 8 secs.	Telegraph lines outside office oscillated	No previous tremors or rumblings or premonitions of any kind. The shocks were sudden.
Cambridge VI.	10.53*	Severe and prolonged	S.E. to N.W.	$\frac{3}{4}$ min.	A few clocks stopped, and a few glasses knocked off a shop-shelf	No previous warnings. Shock came suddenly. Several persons heard rumbling as shake approached.
Helensville VII.	10.54*	Sharp ..	S.E. and N.W.	15 secs.	Crockery broken, and other articles thrown down and displaced, causing people to rush out of houses	
Tauranga IV.	10.55*	Sharp ..	S.E. to N.W.	About 5 secs.	Clock stopped in post-office ..	The rumble distinctly heard, say, a second or so before the shock felt. Window-sash weight could be heard knocking against wall.
Hawera IV.	11.3	Sharp ..	S.W. to N.E.	3 secs...	One of the office clocks stopped at 11.3	Liquid in battery-jars used for recording observation:—the marks left on side of cells show approximate direction and severity.
Katikati III. to IV.	10.52	Very severe	N. and S.	2 min.		
Grahamstown III.	10.53	Two smart shocks	N. and S.			

* Times checked by New Zealand mean time.

Place.	Time of Beginning of Shock. (N.Z.M.T.)	Nature of Shock.	Apparent Direction.	Apparent Duration.	Effects.	Remarks.
Coromandel .. III. to IV. Auckland .. VII. or VIII.	A.M. 10.55 10.54*	Sharp shocks "Severe" ("sharp")	About S. to N. W. to E.	S o m e secs. 15 secs.	Clocks stopped. Crockery thrown down and broken. Several chimneys reported overthrown. Bricks dis- lodged from a badly - built brick wall	Loud rumbling noise immediately pre- ceded and accompanied the shock. Professor Aldis corroborates time; mentions second shock ten, fifteen, or thirty minutes later; very slight. Direction observed precisely N. to S. Vibrations of water in a pail in kitchen E. to W., approximately.
Waikato .. VII. or VIII.	..	..	..	..	Windows broken, bells rung. Children in school thrown off seats.	
Hamilton .. III. to IV.?	10.54	..	S. to N.	20 secs.		
Raglan .. VII.	..	..	N. to S.	..	A few windows broken. Pen- dulum clock at rest placed east-and-west started going by shock	Natives first heard a loud report out at sea.
Waiuku .. VII.	10.55	..	S.E. to N.W.	15 secs.	Stopped clocks	Loud rumbling.
Wanganui .. III.	10.55*	Very slight indeed	..	2 secs...	.. ..	Very slight tremor (preceding), hardly perceptible.

* Times checked by New Zealand mean time.

NOTE FROM AUCKLAND.—"Shock felt more or less severely over the Auckland District, excepting the north, beyond Kaipara.—W. S. FURBY, Auckland P. O."

which probably includes the chief epicentrum. The roman numbers under the names of the places in the table show the degrees on the Rossi-Forel scale of intensity that seemed most nearly to correspond to the details given. The isoseismal III., it will be seen, would lead us to suppose a focus not very far from N or A, and certainly would prepare us to believe that there were two distinct shocks. Both these methods, Time and Intensity, seem therefore to point to the same conclusion.

3. To sum up. A possible hypothesis, which explains all or nearly all the facts, is that a fault-movement began below A, going northwards, was accelerated rapidly at or near B, and continued for some time afterwards in minor shocks along the line AB. There is no evidence of the existence of such a fault, nor is there likely to be, as the region indicated lies under the sea.

4. The velocity of propagation was between twelve and fifteen miles a minute.

ART. LVI.—*Notes on the Earthquake of the 5th July, 1891, in Cook Strait: an Attempt to define the Epicentrum.*

By GEORGE HOGBEN, M.A.

[*Read before the Philosophical Institute of Canterbury, 1st October, 1891.*]

THIS was a slight earthquake, without any marked effects, and I do not propose to deal with it at any length. Its sole interest is derived from the fact that the observations of it, though not many in number, were sufficiently exact to enable us to ascertain the epicentrum very nearly. The data—all obtained through the Telegraph Department—are these:—

	Time.	Direction.	Duration.
Blenheim ..	10.53 p.m.	W. to E. (but un- certain)	10 secs.
Upper Hutt ..	10.55 p.m.	N.E. to S.W.	3 secs.
Masterton ..	10.53 p.m.	N.E. to S.W.	about $\frac{3}{4}$ min.
Woodville ..	10.54 p.m.	W. to E.	5 secs.
Marton ..	10.53 p.m.	N.E. to S.W.	8 to 10 secs.
Foxton ..	10.55 p.m.	N. to S.	5 secs.
Wellington ..	10.55 p.m.	S.E. to N.W.	5 secs.
Picton ..	10.52 p.m.	N. to S.	10 to 15 secs.
Featherston ..	10.52 p.m.	N.W.	2 secs.

The times are those of the beginning of the shock: the first six are stated to have been verified by New Zealand mean time, the last three being given to the best of the officers' belief to N.Z.M.T. No qualification of the times at the Upper