bury, where the shock was severe, no damage whatever was done; nor do I believe that any tidal wave was noticed on the sea coast. A wave, however, came up the Avon to within two miles of Christchurch. I was at the time living close to the river, and heard the rushing sound of the water; I did not however know what it was until the next morning when I noticed that the river weeds had been washed on to the grass, for about one foot in height. It may be worth recording that a heavy rain from the north-west fell on the day of the earthquake; this is a very rare occurrence in the neighbourhood of Christchurch.

It is worthy of notice that earthquakes happened along the coast of South America at the same time, and were felt by different ships at sea in the neighbourhood of New Zealand. The earthquake waves in Palliser Bay were about 30 feet high, and showed a white crest although the night was cloudy; they succeeded the shocks. One family would certainly have been drowned had not some sailor, who had been on the South American coast, recognized the character of the approaching wave the moment it became visible.

A remarkable wave was observed some time during the month of March, 1856, by Mr. Michael Studholme, who happened to be near the beach at the mouth of the Waiho river. He saw the wave at some distance in the offing, approaching from a south-easterly direction; it was many feet in height and broke with great violence on the beach, washing over into the lagoons which there line the shore; shortly after, on riding towards Timaru, he noticed the effects on the beach at different places. It does not, however, appear to have been noticed by any one at Timaru.

I happened to be at Akaroa some day during that month, and whilst engaged in surveying near low-water mark, was surprised to find the water suddenly rise, which it continued to do for some minutes, and then again began to ebb. I remember mentioning it at the time to some of the inhabitants of Akaroa, but not thinking of earthquake waves we attributed it to a change of wind in the offing sending in the tide before the proper time. This supposition would not, however, account for the ebb again commencing, and I now believe it was the same wave noticed by Mr. Studholme.

The recent earthquake waves have been so fully and ably reported upon by Captain Gibson, and our learned president, Dr. Haast, that it is not necessary for me to add anything to their observations.

ART. LVI.—*On a series of Tables for facilitating the Calculations of Altitudes from Barometrical Observations in Mountainous Countries; with explanations.** By E. DOBSON, C.E., Assoc. Inst. C. E.

[*Abstract, by the Assistant Secretary, of Paper read before the Wellington Philosophical Society, November* 13, 1869.]

THE author commenced by explaining, that in the year 1865, when engaged in exploring the Canterbury Alps, for the purpose of finding a route available for the construction of a coach road, between the eastern portion of that province, and the then newly-discovered goldfields on its western coast, the necessity for such tables as he proposed to describe had been manifest to him.

"The broken character of the country, and the denseness of the forests, which stretch everywhere from the banks of the rivers up to the line of

---

* The valuable tables appended to this paper, not being suitable for insertion in this volume, have been returned to the author for separate publication in a convenient form for the use of engineers —ED.

perpetual snow, would have rendered futile any attempt to obtain a connected series of levels by the use of the spirit level, and therefore not only the trial levels, but those required for the location of the selected route were calculated from barometric observations.

"As this, however, involved a great mass of calculations, the author was led to consider whether the reductions of the barometer observations could not be effected by simpler means than those commonly used. It then occurred to him that if the altitude corresponding to any reduced barometer reading were divided by the difference in the height of the mercurial column at the sea level, and at the given altitude, the resulting quotient would be a factor, which might be used for calculating approximately the altitudes corresponding to other barometric readings within a certain limited range.

"Thus, assuming the height in inches of the mercurial column at the sea level = 30,

And taking a series of reduced barometric readings as . .	29	28	27	26 etc.
The differences between these readings and that at the sea level are . . .	1	2	3	4 etc.
And the corresponding altitudes at a mean temperature of 32° Fah. . . .	ft. 886·9	ft. 1804·8	ft. 2756·2	ft. 3743·5 etc.
Which altitudes divided by the differences of pressures would give the factors .	886·9	902·4	918·8	935·9 etc.

which could be used for calculating approximately the altitudes corresponding respectively to the barometer readings between 30 and 29, 29 and 28, 28 and 27, 27 and 26, etc.

"Following up this idea, it further became apparent, that as the differences of mercurial pressure are expressed in inches and decimals, the decimal division of the differences between these factors would supply the means of calculating factors for all intermediate barometric readings, not, it is true, with perfect accuracy, but within limits of error which may be practically disregarded; the maximum error, from the employment of the factors in the calculations, in the resulting altitudes, for elevations under 3250 feet, not exceeding four inches.

"It will be seen at once, that in this system of calculating altitudes, the correction for the difference between the actual and the tabular mean temperature will be most readily made, not by reducing the barometer readings, but by correcting the tabular altitudes; and also that if each of the factors be divided by 480, the resulting quotients will give the constants by which they must be respectively altered, for each degree of difference between the actual and the tabular mean temperature. The result of the above considerations was the construction of the following table (calculated for a mean temperature of 32° Fah., and a mercurial pressure at the sea level of 30 ins.) by which the calculation of altitudes from barometric observations may be effected rapidly, and with the use of very few figures, without the necessity of referring to a table of logarithms, and with a corresponding diminution in the liability to numerical errors.

Reduced Barometer readings.	Difference in the height of the mercurial column, at the sea level, and at given altitudes.	Height, in feet, per inch of difference in the height of the mercurial column.	Corrections per 1° Fah. difference in temperature.	Altitudes, in feet, above the sea level.
inches.	inches.	feet.	feet.	feet.
26	4	935·9	1·9	3743·5
		Diff. 17·1		
27	3	918·8	1·9	2756·2
		Diff. 16·4		
28	2	902·4	1·9	1804·8
		Diff. 15·5		
29	1	886·9	1·8	886·9
		Diff. 14·9		
30	0	872·0	1·8	Sea level.

"The table in the above form having proved of great service in the author's professional practice, it has been extended for publication, by calculating the altitudes for every hundredth of an inch difference in the height of the mercurial column, from 30 inches to 26 inches; and a column of temperatures has been added, which will be found of considerable assistance in calculating the difference between the actual and the tabular temperature at any given altitude."

Mr. Dobson then proceeds to give the principles upon which the tables are framed, at greater length; with full explanations of the tables themselves, directions for registering the observations, and for using the tables in the calculations of altitudes.

A chapter is devoted to "General Observations," in which he states that, "in tolerably level country, and in clear, calm weather, the observations may be extended to a distance of from fifteen to twenty miles from a well-ascertained bench-mark without risk of serious error. If, however, there is much wind, not only must these limits be greatly reduced, but it will be advisable that the observations at each of the upper stations should be twice repeated at ten minutes intervals, in order that it may be ascertained whether the barometer is rising or falling, and that the index error may be adjusted according to the directions whence the changes come.

"It must, however, be remembered that the fluctuations of the barometer due to variations in the quantity of aqueous vapour in the atmosphere, as well as to other causes, are so great as to render all barometric observations valueless, as engineering data, which cannot be corrected for the deviations from mean atmospheric pressure, by comparison with a register kept at some neighbouring station, of which the altitude has been ascertained."

The author suggests that "although the mercurial barometer should always be used, when practicable for the observations at permanent meteorological stations, it is at once too cumbrous and too fragile for the rough work of a reconnaissance survey. For this purpose a properly compensated aneroid barometer may be substituted, with advantage, for the more perfect instrument. Up to the present time, the use of the aneroid barometer has, with trifling

exceptions, been confined to forecasting the weather, the somewhat intricate nature of barometric calculations, having prevented its general adoption as an instrument for taking levels. It is hoped that these tables, by removing the difficulties referred to, will pave the way to a more extended use of this valuable instrument which is especially adapted for taking trial sections in wooded and mountainous districts, and with which, under proper management, very close results may be obtained, without that expenditure of time and money, involved in the use of the spirit level under such circumstances."

ART. LVII. — *The earth of New Zealand, a bad Conductor of Electricity, as compared with that of other countries.* By F. E. WRIGHT.

[*Read before the Philosophical Institute of Canterbury, September* 1, 1869.]

MY attention was first attracted to this subject under the following circumstances :—

In March, 1867, I had occasion to visit Hawkswood, in the Nelson Province, and I returned to Christchurch viâ the Cheviot Hills, following the line of telegraph all the way back. Between Hawkswood and Glenmark I saw that a large number of the telegraph poles were lying on the ground; they were birch saplings, and most of those still standing appeared to be so badly rotted at the point of their emergence from the soil, that I have but little doubt many more fell during a south-west gale which detained me two days at Mr. Moore's station. I need hardly state that the poles for the whole of the distance, here referred to, have been replaced by others of a more substantial character.

Under these circumstances, on arriving at Christchurch, I felt it almost useless to ask at the Telegraph Office, if the line was open to Wellington, and was greatly surprised to find that messages could be forwarded. This was at variance with my previous knowledge of the subject, and I thought it so curious and exceptional, that I have since lost no opportunity of enquiring into the matter, the result of which has been a settled conviction on my mind, that an altogether anomalous state of the soil, so far as its conductibility of electricity is concerned, obtains in these Islands.

Mr. de Sauty, the late electrician of the telegraph department, who is quoted as an authority in several recent works on telegraphy, and who had been engaged on telegraph lines in various parts of the world, assured me that he was unaware of any other country or place exhibiting similar characteristics.

Mr. Bird, the present Provincial Inspector of Telegraphs, informed me, a year or two since, that were the conditions of the earth as a conductor of electricity the same here as in Europe or America, it would have been quite hopeless, for months together, to have endeavoured to send a telegraphic message in any direction from Christchurch, there being faults in all the lines, which would have proved sufficient to destroy the connection in any other place but New Zealand.

Mr. Meddings, attached to the Telegraph Office in this city, who takes the greatest personal interest in his vocation, and works at it with a zeal which may be termed enthusiastic, has made many interesting experiments on the subject. He tells me that he finds the greatest difficulty in getting a good *dead earth* in Christchurch, or in fact in any part of New Zealand to which he has been called by his employment.

This anomalous state of the earth in this country was at first to some extent accounted for, in my mind, by the dryness of the soil, thinking that the