THE HEIGHT OF BEN LOMOND.

By L. F. Giblin, B.A., E. L. Piesse, B.Sc., and H. R. Hutchison, Authorised Surveyor.

(Read 14th April, 1913.)

Map

In a paper read before the Society in 1907(1), two of us gave an account of observations made with aneroids on Ben Lomond in 1906 and 1907 with the object of determining the difference of height between Legge Peak(2), the highest summit in the northern part of the Ben Lomond range, and the trigonometrical station at the southern end of the range. The trigonometrical station is stated on the official maps of Tasmania to have a height of 5010 feet; Cradle Mountain is stated to be 5069 feet, and the Ben Lomond station comes next below it, being thus the second highest of the officially recorded summits.

The observations in 1906 made Legge Peak 140 feet higher than the trigonometrical station; and in 1907, 160 feet. From the former, the height of Legge Peak was 5150 feet, from the latter 5170 feet, and the mean of the two results was 5160 feet. If this result were correct Legge Peak was nearly 100 feet higher than Cradle Mountain, and was the highest known summit in Tasmania. But the result had been obtained with aneroids not of the best pattern for this purpose, and not used in the best conditions, and it was desirable that the difference of height should be ascertained by survey. An opportunity to revisit the mountain did not occur until 1911. A survey was then made which in part confirmed the height obtained in 1906 and 1907, but the result was not conclusive, and another survey was accordingly made in 1912, and this placed the height of Legge Peak beyond doubt.

(1) L. F. Giblin and E. L. Piesse, Note on the Height of Legge Tor (*Proc. Roy. Soc. Tas.* 1906-7, xxxvii.-xl.).

(2) The name Mt. Legge was proposed in the paper just mentioned, but in the title of the paper the name was altered to Legge Tor as this was understood to be the form desired by the Department of Lands and Surveys. In the County chart Cornwall No. 3 the summit has been called Legge Peak.

At Christmas, 1911, a party consisting of Messrs. W. F. D. Butler, J. A. Johnson, A. F. Weber, and two of the writers (L. F. Giblin and E. L. Piesse) spent several days at Ben Lomond. Leaving Hobart by the morning train, the party was met at Avoca station by Mr. C. R. Foster, who made all arrangements for the ascent of the mountain and enabled the party to reach before dark the old Ben Lomond Hotel, 11 miles from Avoca, and about 2400 feet above sea-level. The "Hotel," it should be mentioned, is untenanted, and travellers will be wise to make their own camp. Next morning, Mr. Foster's horses helped the party to the Upper Camping Ground, about 3700 feet, and from there the loads were carried to the plateau. Arrived at the moor, the party went southwards to the Stacks Bluff, on which is the trigonometrical station. There a base rather more than a quarter of a mile long was measured, and with a 5-inch Everest theodolite angles were taken to ascertain the distance and elevation of Legge Peak. Then the party went on to Youl's Lake, where a camp was made. The results of the day's observations were computed, and the height of Legge Peak was found to be 5158 feet.

As the object of the expedition seemed to be attained, the next day, again a fine one, was spent in a visit to Legge Peak instead of in making a check survey. This was attempted on the following day, but the weather had broken and it was impossible to do more than measure a second base on the moor south of the Nile gorge, and move camp to a more sheltered spot, a little flat about 400 feet above the Upper Camping Ground and at the foot of the talus slope from Wilmot Bluff. Three of the party had to return to Hobart next day, but Messrs. Giblin and Piesse remained, and were able to take the required angles at the second base. Satisfied with these, they returned to the flat, and moved camp to the old Hotel, in preparation for an easy stage next day into Avoca.

But when the day's observations were examined that night at the camp fire, it was found that they did not confirm the first day's work at the Stacks Bluff. The observations from the two ends of the Nile gorge base made Legge Peak, from one end of the base, 13 feet lower than the trigonometrical station, and from the other end 6 feet. The apparent agreement of these two results

averted suspicion from the instrument, and no other explanation could be imagined. The supply of food was almost exhausted, but there was just enough for another day's stay, so an early start was made with the theodolite next morning, and the site of the previous camp reached by eight o'clock. Then a cloud covered the summit, and did not lift for eight hours. At last, at nearly five o'clock, the fog lifted, and vertical angles were taken from the trigonometrical station to the ends of the Nile base (which, of course, had not been marked on the first day) and again to Legge Peak. The angles to the base agreed closely with the angles taken in the opposite direction from the ends of the base to the trigonometrical station, and the angles to Legge Peak were also nearly the same as those taken on the first day, and so the mystery of the discordant results was still unsolved. However, it was not possible to do any more, and next day the party had to go in to Avoca. It was only after the return to Hobart that an examination of the instrument showed that some parts of it had worked slightly loose, so that it would sometimes give a correct vertical angle and sometimes a quite incorrect one. Its vagaries had not been discovered in the field, because on each test made of it the reading confirmed the previous reading.

It was tempting to disregard the results from the Nile gorge base, and to treat the height, 5158 feet, obtained from the Stacks Bluff base, agreeing so closely with the height given by the aneroids in 1906 and 1907, as correct. However, it was safer to wait for a confirmation, and the result was therefore not published.

At Christmas, 1912, the writers and Messrs. Butler and Weber went again to Ben Lomond. Mr. Foster again made all arrangements for us, and at some inconvenience accompanied us as far as the Upper Camping Ground. This time we decided to avoid the labour of carrying our stores across the moor, and we made our camp at last year's site on the flat below Wilmot Bluff, a position quite convenient for our work. Relying on a little stream (the head of the Ben Lomond Rivulet) which we had found above this flat in 1911, we had no fears for a supply of water; but the supply was much scantier than in the previous year, and this spot, otherwise a very pleasant camp site, might be without water in a dry season. In spite of the heavy rains during December, we found the moor

much drier than usual. The beautiful pools which usually are found everywhere over the plateau were for the most part dry, and the bright vegetation which grows in and round them was withered. The blaze of colors which Ben Lomond shows in summer was duller than in other years; the sage bush and the yellow bush had their usual tints, but there was scarcely a flower on the acres which are often covered with the white and red and orange blossoms of the richea.

We first remeasured the base (*TA*) at Stacks Bluff. In 1911 this had been found to be 1554·42 feet and 1554·43 feet in two measurements, each made with a 300-foot $\frac{1}{8}$-inch steel band in the usual way. When remeasured in 1912 with the same band, the length was found to be 1553·0 feet; but owing to a high wind the measurement was probably not as accurate as those made in 1911. We took the length to be 1554 feet.

This base is of course a very short one. But it is to be remembered that our object was not to find the distance of Legge Peak (which was nearly seven miles)—an object for which the base would have been unsuitable, as any error of measurement would be exaggerated twenty times, and in addition there would be an error in calculation resulting from the smallness of the angle at Mt. Legge—but to determine a difference of height which was only about one-tenth of the length of the base. An error of a foot, then, in the measured length would give an error of only a little more than an inch in the difference of height, and from this point of view the base was long enough.

Mr. Hutchison then measured the horizontal and vertical angles from the ends of the base to Legge Peak, and to the ends of a new base *CD* which another member of the party had marked meanwhile near last year's base at the Nile gorge. Owing to a high wind and other circumstances the angles are not quite complete, but even apart from the angles taken at the second base, they give two determinations of the height of Mt. Legge, and with these angles they give an ample check.

On the following day we measured the new base at the Nile gorge (1366·5 feet), and Mr. Hutchison took the necessary angles there. We also laid out two other bases, *CB*, *BE*, and used these to determine the heights of the two summits of Ragged Mountain, an outlier to the north-west of Ben Lomond.

1913.

The instrument used was a 5-inch Troughton and Simms transit theodolite reading on each circle by two verniers to 20″. The angle obtained at each setting is given below.

The degree of accuracy of the angles appears from the triangles *ACD*, *CDT*, in each of which all three angles were measured. The sum of the measured angles of the triangle *ACD* is 180° 0′ 17″, and the sum of the measured angles of the triangle *CDT* is 179° 59′ 53″. For the vertical angles, a test of accuracy is given by the angles between *A* and *C* and between *A* and *D*, which were measured in both directions. After applying the usual correction for curvature and refraction, the difference between the angles *A* to *C* and *C* to *A* is 51″, and the difference between the angles *A* to *D* and *D* to *A* is 3″. A test of the accuracy of the angles and measurements of length combined is obtained by calculating the distance from the trigonometrical station to Legge Peak, first from the Stacks Bluff base and the angles observed there, and second from the Nile gorge base and the angles observed at it. The results are 35,280 feet and 35,260 feet, whence it appears that the lengths required for determining the difference of height are known with sufficient accuracy.

From the abstract given below of the calculations, it will be seen that the height of Legge Peak was determined in four ways calculated in pairs from independent observations at the two bases. The results are:

HEIGHT OF LEGGE PEAK.

How Obtained.	*Calculated Height.*
Direct from *T*	5160·0
From *A*	5160·6
From *D*	5160·6
From *C*	5158·3

These results and the result (5158) feet obtained in 1911 justify the adoption of 5160 feet as the height of Legge Peak, which accordingly is the highest known summit in Tasmania, a satisfactory conclusion to the investigations of the height of Ben Lomond commenced by Col. W. V. Legge in 1906. The agreement between the results by aneroid and by the theodolite is remarkably close, and could not be expected to occur again in similar conditions.

The claims of Barn Bluff to be higher than its neighbor, Cradle Mountain, have still to be tested by survey.

Barn Bluff may prove to be higher than Cradle Mountain, but no one, so far as we know, has suggested that it is likely to be as much as 90 feet higher, and there is little probability that Legge Peak will be displaced from its position at the head of Tasmanian summits.

The results of the calculations for *N* (the western summit) and *S* (the eastern summit) of Ragged Mountain are also given below. The height of the northern summit is about 4440 feet, and of the southern about 4490 feet. The mountain has thus a respectable place in the list of Tasmanian summits, although perhaps not quite as high a one as its prominent appearance from Launceston and elsewhere would suggest.([3])

The map published with this paper is based on a rough survey made by Colonel Legge. We are indebted to Mr. A. F. Weber for preparing it for reproduction. The aneroid heights shown on the map depend for the most part on single unchecked observations. The topographical features of the map are shown on the county chart of Cornwall (No. 3), issued by the Department of Lands and Surveys, which has also been drawn from Colonel Legge's survey. Most of the names given on our map are not, however, shown on the official chart.([4])

([3]) Ragged Mountain can be seen on a clear day from Mt. Wellington. Legge Peak is also in view, between Ragged Mountain and the southern summit, but it is not conspicuous enough to be distinguished as a separate summit in the general high area at the north of Ben Lomond.

([4]) Colonel Legge has sent us the following explanation of names on the Ben Lomond plateau given by him in the rough survey he made in the years 1906-9 :—

"As I regarded the Ben Lomond plateau as the most remarkable physiographical feature in the State, it seemed fitting that the majority of the names should have some historical significance : accordingly—

1. The lake-source of the Nile, its gorge, the 'cirque' in the escarpment, and the isolated fell adjoining the river's descent through the latter, were named after explorers connected with discoveries at the sources of the parent river in Africa.
2. Dominant and commanding features of the great escarpment, as also important surface characteristics of the plateau : after governors, officials, surveyors, &c. of the State.
3. Other features on the plateau : after fellow-explorers and assistants in the survey.
4. The remarkable eroded-down valley, dissecting the plateau, at the upper entrance of the Speke Gorge : after our good Queen.
5. The lofty cliff buttress as seen from the Break-o'-Day Valley, often standing up alone against the cloud in the 'amphitheatre,' after the lonely and mysterious 'Sentinel of Egypt'—the 'Sphinx.'"

ABSTRACT OF OBSERVATIONS.

T, a spot on the rock within the "stockade" at the trigonometrical station on the southern summit. We did not see any mark of the original station, and its position is somewhat uncertain.

A, the top of a flag at the eastern end of the Stacks Bluff base.

B, *C*, *D*, *E*, tops of flags at the ends of the bases south of the Nile Gorge.

L, the base of the cairn erected in 1907 on Mt. Legge.

N, *S*, the highest points visible from *B*, *C*, *E*, of the western and eastern summits of Ragged Mountain.

Lengths of Bases.

(Reduced to the horizontal.)

TA	Measured in 1911, 1554·42, 1554·43 feet. Measured in 1912, 1553·0 feet. Length adopted, 1554 feet.
CD	1366·5 feet.
BC	1369 feet.
BE	1204 feet.

HORIZONTAL ANGLES OBSERVED.

Each entry in the columns "Face Right," "Face Left," is the mean of the vernier-readings at one setting.

	Face Right.			Face Left.			Mean.			Corrected Angle. (1)		
	°	′	″	°	′	″	°	′	″	°	′	″
LTA	75	12	40	75	12	20	75	12	35			
						40						
CTD	5	31	30	5	30	45	5	31	07			
			20			55						
CAD	5	21	50	5	21	40	5	21	45			
DAL	16	27	15	16	27	20	16	27	17			
LAT	102	19	10	102	19	45	102	19	27			
LCD	71	37	05	71	37	20	71	36	55			
		36	40		36	35						
LCA	144	20	40	144	21	10	144	20	45			
		20	15		20	55						
LCT	150	34	00	150	34	10	150	34	00			
		33	40		34	10						
CDL	104	59	25	104	58	55	104	59	00			
		58	50		58	50						
CDA	101	54	10	101	54	50	101	54	42	101	54	32
		54	55		54	55						
CDT	95	31	25	95	31	45	95	31	41	95	31	45
		32	00		31	35						

(1) Corrected to make sum of observed angles of triangle 180°.

VERTICAL ANGLES.

Each entry in the columns "Face Right," "Face Left," is the mean of the vernier-readings at one setting.

Angle.	Face Right.			Face Left.			Mean.			Correction. (2)		Corrected Angle.		
	°	′	″	°	′	″	°	′	″	′	″	°	′	″
T (+ 4·5) to L	+ 0	10	40	+ 0	12	50	+ 0	11	42	+ 2	29	+ 0	14	11
			35			45								
			35			45								
T (+ 4·5) to A	— 0	50	30	— 0	47	25	— 0	48	57	+ 0	06	— 0	48	51
A (− 1·0) to L	+ 0	12	55	+ 0	15	30	+ 0	14	10	+ 2	29	+ 0	16	39
			40			35								
A (— 1·0) to D	— 1	41	20	— 1	38	55	— 1	40	07	+ 0	59	— 1	39	06
A to D												— 1	39	20 (3)
A (— 1·0) to D	— 1	33	10	— 1	34	50	— 1	34	00	+ 1	01	— 1	32	59
A to D												— 1	33	13 (4)
C (— 1·2) to L	+ 1	21	40	+ 1	25	10	+ 1	23	50	+ 1	35	+ 1	25	25
		22	45			25								
		22	30			30								
C (—1·2) to D	— 0	45	05	— 0	42	15	— 0	43	40	+ 0	06	— 0	43	34
C (— 1·2) to T (+ 6)	+ 1	37	20	+ 1	39	20	+ 1	38	31	+ 1	00	+ 1	39	31
			25		40	00								
C (— 1·2) to A	+ 1	30	30	+ 1	32	25	+ 1	31	38	+ 1	01	+ 1	32	39
			40		33	00								
C to A												+ 1	32	22 (4)
D (— 1·2) to L	+ 1	27	30	+ 1	30	00	+ 1	28	40	+ 1	33	+ 1	30	13
			10			00								
D (— 1·2) to T (+ 6)	+ 1	43	35	+ 1	46	00	+ 1	44	56	+ 0	59	+ 1	45	55
			40			30								
D (— 1·2) to A	+ 1	37	30	+ 1	40	00	+ 1	38	41	+ 0	59	+ 1	39	40
			15			00								
D to A												+ 1	39	23 (3)

(2) Correction for curvature and refraction, + 4·25″ per 1000 feet. This correction is obtained by taking the coefficient of refraction to be ·070 (see Close's Text Book of Topographical and Geographical Surveying, p. 29).

(3) A to D, 1° 39′ 20″; D to A, 1° 39′ 23″; mean, 1° 39′ 21″.

(4) A to C, 1° 33′ 13″; C to A, 1° 32′ 22″; mean, 1° 32′ 47″.

CALCULATION OF HEIGHTS.

Point.	How obtained.	Calculated Height.	Height Adopted.
		feet.	feet.
T	Trigonometrical Survey of Tasmania	...	5010
A	Direct from *T*	4992·4	4992·4
D	Direct from *T*	4587·4	4588·1
	From *A*	4588·8	
C	Direct from *T*	4607·6	4606·8
	From *A*	4606·2	
	From *D*	4606·6	
L	Direct from *T*	5160·0	5160
	From *A*	5160·6	
	From *D*	5160·6	
	From *C*	5158·2	
N	From *C*	4439	4440
	From *B*	4444	
	From *E*	4442	
S	From *C*	4491	4490
	From *B*	4492	
	From *E*	4491	

LIST OF PAPERS, &c., RELATING TO THE PHYSICAL GEOGRAPHY AND GEOLOGY OF BEN LOMOND.

1845.

P. E. De Strzelecki. Physical Description of New South Wales and Van Diemen's Land. (London: Longmans, Brown, Green and Longmans, 1845. 8vo.)

Count Strzelecki gives the following in his table of heights (p. 44):—

"Mount Ben Lomond, culminant point, 5002,
, N.W. point, 4354,
, South Bluff, 4500."

There is nothing, however, to show where his "culminant point" was. His "South Bluff" may have been Sphinx Bluff (4580 feet), but it is a name more suitable for the Stacks Bluff (5010). If South Bluff was the Stacks Bluff, Strzelecki's table shows that he observed a higher summit elsewhere on the mountain. Many of his heights in other parts of Tasmania were inaccurate, although he seems to have made the most of his apparatus. The instruments used were Gay Lussac's syphon mountain barometers and Wollaston's boiling point apparatus (p. 40). Count Strzelecki describes the scenery of Ben Lomond. Of the plateau he says (p. 67): "The scene is here one of unbroken solitude, silence, and desolation."

1892.

A. Montgomery (Geological Surveyor). Report on the Ben Lomond District. (*In* Report of the Secretary of Mines (Tasmania) for 1891-2, pp. 25-40. Journal and Papers of Parliament, 1892, Vol. XXVI., No. 79.)

Geological section from Avoca to Ben Lomond.

1901.

George A. Waller (Assistant Government Geologist). Report on the Tin-mining District of Ben Lomond. (*Issued with* Report of the Secretary of Mines (Tasmania) for 1901-2, pp. 1-41. Government Printer, Hobart, 1908. 8vo.)

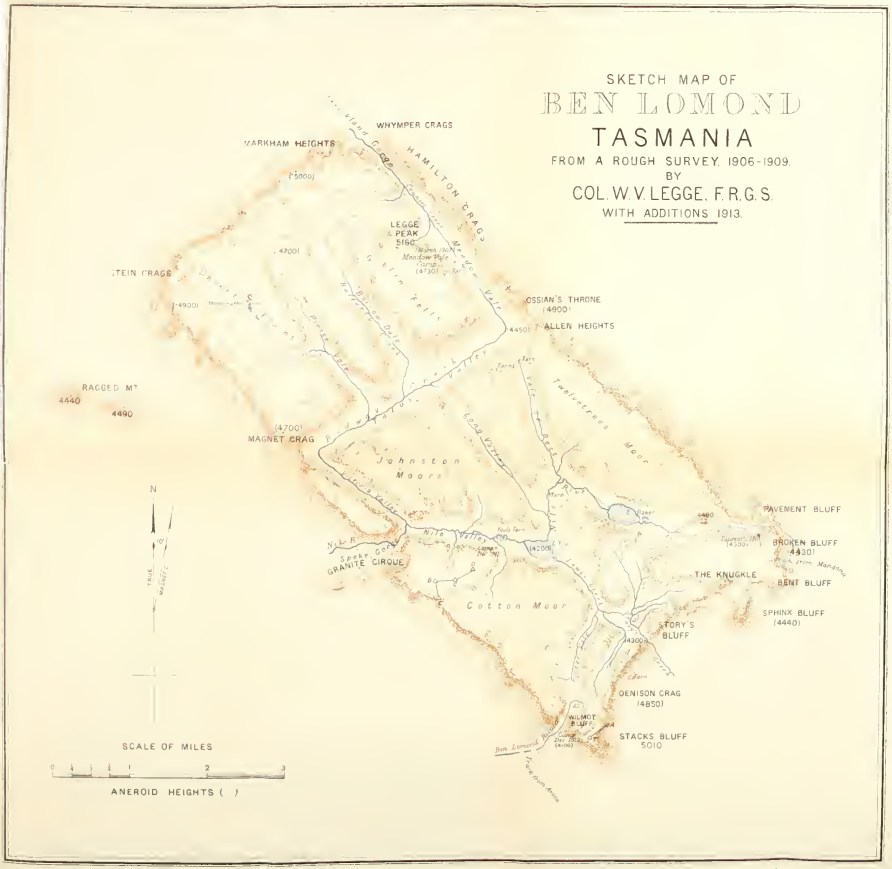
Geological sketch-map of the district. Ideal section from Ben Lomond Butts to Mt. Rex.

1907.

Colonel W. V. Legge. An Investigation into the Physiography of the Ben Lomond Plateau, Tasmania. (*In* Report of the Eleventh Meeting of the Australasian Association for the Advancement of Science, Adelaide, 1907, pp. 521-5.)

Colonel W. V. Legge. Note on the Ben Lomond Plateau, and the Discovery of High Land at the North End. (*In* Proceedings of the Royal Society of Tasmania, 1906-7, pp. xxxiv.-xxxvi.)

L. F. Giblin and E. L. Piesse. Note on the Height of Legge Tor. (*In* Proceedings of the Royal Society of Tasmania, 1906-7, pp. xxxvii.-xl.)


SKETCH MAP OF
BEN LOMOND
TASMANIA
FROM A ROUGH SURVEY. 1906-1909.
BY
COL. W.V. LEGGE, F.R.G.S.
WITH ADDITIONS 1913.
WHYMPER CRAGS
MARKHAM HEIGHTS
(5000)
HAMILTON CRAGS
LEGGE'S PEAK
5162
(4700)
(4900)
OSSIAN'S THRONE
(4900)
ALLEN HEIGHTS
(4450)
RAGGED MT
4440
4490
(4700)
MAGNET CRAG
Johnston Moors
Cotton Moor
Twelvetrees Moor
PAVEMENT BLUFF
BROKEN BLUFF
(4330)
THE KNUCKLE
BENT BLUFF
SPHINX BLUFF
(4440)
TORY'S BLUFF
(4300)
DENISON CRAG
(4850)
WILMOT BLUFF
STACKS BLUFF
5010
GRANITE CIRQUE
N
SCALE OF MILES
ANEROID HEIGHTS ( )

SKETCH MAP OF BEN LOMOND

CORRECTIONS

For "Granite Cirque" read "Grant Cirque."

The base-lines CD, BC, BE are about half-a-mile north-west of the position shown on the map.