LII. On the measurement (by Trigonometry) of the heights of the principal Hills of Wensleydale, Yorkshire

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tainly not the coal itself, but the outburst of a bed of such argillaceous schist as invariably accompanies coal-beds, mixed with a few small pieces of coal, probably proceeding from the outburst or crop of a seam within a very short distance of the spot. So strong indeed are the indications of coal at this place, that of its existence in the immediate vicinity I have not the slightest doubt. Of its qualities, thickness, &c., of course no idea can be formed without boring; but there is every reason to suppose that the same beds will be found here as those which are at present sinking to at Whitwick and Ibstock.

Note.—From the hasty manner in which this survey was made, I had no opportunity of taking elevations; but it is extremely probable that the out-break of the coal-measures through the new red sandstone near Birstall is connected with the elevation of the ground. Near Ashby also I observed the like appearance under similar circumstances, where, although the low grounds are occupied by the deposit of new red sandstone, yet on the top of a hill a bed of siliceous sandstone, evidently belonging to the coal-measures, protrudes itself to the surface, and is quarried for the purposes of building.

F. F.

LII. *On the Measurement (by Trigonometry) of the Heights of the principal Hills of Wensleydale, Yorkshire.* By JOHN NIXON, Esq.*

EARLY in June last I commenced the above undertaking, and succeeded, notwithstanding the extremely unfavourable state of the weather, in completing the requisite measurements by the middle of July. With a view to increase the accuracy of the survey, the third or verification angles of some of the principal triangles were, however, obtained in September, at Ingleborough and Whernside; and in November, at Shunnor Fell: yet so unsatisfactory, in consequence of the continued haziness of the atmosphere, were the observations, as to render it doubtful whether it would not have been preferable to have rejected them.

In the selection of the hills, the transverse and lateral (or boundary) ridges, of which Wensleydale entirely consists, were surveyed; and the principal passes (or extreme depressions of the ridges) being ascertained, the loftiest point of ground comprehended between every two adjacent passes was carefully determined and marked for measurement. At the head of the dale, several of the transverse ridges, diverging with a gradual descent from one common crest, terminate in lofty and steep head-lands, or knabs. As no part of hills of this description could with propriety be designated the summit, the measurement of the height of any other point was not attempted.

* Communicated by the Author.

On commencing the survey, it was discovered that the twelve-inch telescopic-level, recently fitted up with extremely fine cross-wires, would not, from some imperfection in the screws of the stop, retain its adjustments. The extreme summit of the hill was, therefore, of necessity estimated by the eye alone previous to the erection of the signal. That no material error had been committed in the few doubtful cases which occurred, was subsequently confirmed; not only where the theodolite was erected, from actual levelling around the signal by means of that instrument, but also by remarking in the course of the observations that the horizontal wire of the telescope, when pointed at the base of the signal on any of the distant hills of about the same altitude as the station, did not dip sensibly below any other part of that hill. The signal on Bakestone Edge was found to be rather lower than a point more to the north; but the latter was evidently within the boundary of Swaledale, and consequently out of the limits of the survey. Viewed from the signal on the Stake Fell, a peat hillock nearly two miles to the south-east was suspected to be quite as high; but it was noted, on repairing there, that a straight line drawn from the hillock through the base of the signal, would touch a point of Water Crag very little below the level of its summit. Now as Water Crag has been determined to be about 350 feet higher than Stake Fell, it proves that the signal was placed considerably above the level of the hillock.

With regard to the structure of the signals, piles or pikes of stone were found on the loftiest points of Water Crag, Shun-nor Fell, and Great Whernside, marking the precise site of signals of the Ordnance Survey. On Settronside, a well-built tower fifteen feet high and nine feet in diameter at the base, recently erected at a distance of forty-five yards to the north-east of the extreme summit of the fell, served as an excellent signal. On Lovely Seat there stands a lofty boundary pike situated some little below the level, but within a few yards of the highest point of the hill; to which point, in lieu of the base of the pike, on the measurement of the *vertical* angles the telescope was invariably directed. Stone towers about eight feet high, and nearly as much in diameter, marked the summits of High Fleak, Bakestone Edge, and Swarth Fell; the latter being erected on a large rock. The signals at Addlebrough and Rover Crag were of a similar description, but much inferior in dimensions. On the wall crossing the summit of Whitfield Hill were heaped, immediately over the most elevated point of ground, a number of loose stones; but this signal, from its insufficient dimensions, could seldom be distinctly seen through the telescope of the theodolite. The other

other signals consisted of conical piles about twelve feet in diameter at the base, and seven or eight feet high, constructed externally of huge sods, and filled up with loose peat-earth. There exists, however, this great objection to a turf-signal placed on a peat moor,—that the observer may not be able to distinguish it, at a remote station, from the peat stacks with which it is liable to be surrounded. For instance, although the pile of sods marking the most elevated point of the extensive and nearly level summit of Penhill, famous for its excellent turbaries, was placed on the northern extremity of an elevated cam (or mound) dividing Walden from Coverdale; yet so numerous were the heaps of peat raised from time to time to the west and north, that the signal, when observed from stations in those directions, could seldom be satisfactorily identified;—an uncertainty which has led to unusual discrepancies in the measurements of such of the distances as relate to that signal.

The horizontal angles were, with one exception*, measured by the six-inch theodolite, minutely described in *Phil. Mag. and Annals*, vol. iii. pp. 83—86. At Bear's Head, Shunnor Fell, Bakestone Edge, and Penhill, immediately on completing one set of observations, the telescope was reversed in position within its Ys, and the observations, notwithstanding the consequent inconvenient position of the tangent screws, carefully repeated. From the unsettled state of the atmosphere, it would frequently occur that some of the distant hills had been obscured by mist or haze during the course of either the first or second set of observations, which rendered it necessary to apply to their readings the uncertain correction of half the mean difference of the two readings, registered for observations with the telescope in both positions. At Settronside, the summits of several of the fells were so rapidly shrouded in vapour that no time was afforded to reverse and re-adjust the telescope; but a few of the observations of most importance were repeated (by turning the screw situated under the parallel plates) on different parts of the divided circle.

It has been remarked, that the signals of the preceding survey, when observed from remote stations, although viewed under an angle considerably greater than that subtended by the fine vertical wire of the telescope, would totally disappear on interposing the latter; but the signals just described, from their superior magnitude, could be bisected in tolerably clear weather with the greatest ease and accuracy. On the occurrence, however, of haze in the atmosphere, the signal, suffi-

* The angle at Rover Crag between Harlen Fell and Penhill.

ciently visible on entering the field of view of the telescope, became gradually more indistinct as it approached the wire, and wholly faded out of view at a distance from it of one or two minutes*.

Another annoying impediment to accurate bisection, the consequence of some defect in the tangent screw, or clamp, of the horizontal circles, requires to be noticed. Occasionally, on turning the screw in the proper direction to rectify an approximate bisection, the vertical wire of the telescope, after refusing for some time to obey its action, would be displaced in azimuth, not gradually, but at once, the quantity due to the degree of revolution of the screw.

In the registers of the measurement of the horizontal angles, there is given for every signal observed the mean of the various corresponding readings, reduced, when requisite, to the centre of the signal. At several of the stations some few of the more distant signals were never sufficiently clear for bisection; but the consequent blanks in the registers, marked M, or C, have been supplied, the former from the accurate data of Colonel Mudge, and the latter, by the following method, from the registers of the other stations. At A the signals C and D were observed, but B could not be seen. From the registers of C and B the angles CBA and BCA are extracted, and the angle CAB obtained by subtracting their sum from 180° . Adding this angle to the reading for the signal C, as given in the register of the observations made at A, (the graduations of the theodolite being numbered from left to right,) their sum is sub-

* I have lately had a telescope fitted up with two horizontal *thick* wires, to each of which is attached a delicate filament, both placed, as exhibited in the figure, in the same vertical line. In making an observation the telescope is moved until the signal appears to be equidistant from the horizontal wires, and as exactly bisected by an imaginary line connecting the two vertical filaments as the eye can estimate. In measuring vertical angles the telescope is to be half inverted within its Ys, and the filaments rendered truly horizontal.

Captain Kater and his associates experienced in hazy weather the same difficulty, or rather impossibility, of bisecting distant signals by the intersection of the (three) wires of their powerful telescope, but succeeded on making use of a minute particle of dust, fixed by Mr. Gardner, on the horizontal wire. (Phil. Trans. 1828, p. 194). This method, it is to be doubted, would scarcely answer if applied to an ordinary telescope.

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stituted in the register for an actual observation of the signal B. When A and B had been seen also from D (or any other station), two or more values of the required reading were procured by the same process of calculation, of which the mean was adopted.

When the distance between two signals (E, A) has been measured from several bases (C, B, &c.), the claim to accuracy of each measurement has been considered, in the determination of the proper mean, to be *inversely* as the greatest error to which, limiting the uncertainty of observation to one minute, it may be deemed liable.

This *maximum* error of the distance in *logarithms* (x) was calculated by the following formulæ, in which d denotes the difference between the log. sine of the angle D, and that of the same angle $\pm 1'$, and a the corresponding difference for the angles A and $A \pm 1'$.

CLASS I.—Given the observed angles E, A, D, each corrected by one-third of the difference of their sum and 180° .

Case 1.—D and A being acute.

$$x = d + a, \text{ when } a = d;$$

$$x = \frac{2d + 4a}{3}, \text{ when } a \text{ exceeds } d;$$

$$x = \frac{4d + 2a}{3}, \text{ when } d \text{ exceeds } a.$$

Case 2.—When either D or A is obtuse.

$$x = \frac{2d + 2a}{3}, \text{ when } a = 2d, \text{ or } d = 2a;$$

$$x = \frac{4d - 2a}{3}, \text{ when } d \text{ exceeds } 2a;$$

$$x = \frac{4a - 2d}{3}, \text{ when } a \text{ exceeds } 2d.$$

CLASS II.—Given the observed angles D and A only.

$$x = a + d; \text{ D and A being both acute, or either of them obtuse.}$$

CLASS III.—Given the observed angles E and A only.

Case

Case 1.—D and A being acute.

$$x = a + 2d.$$

Case 2.—When either D or A is obtuse.

$$x = 2d - a, \text{ when } d \text{ exceeds } a;$$

$$x = a, \text{ when } a \text{ exceeds } d.$$

CLASS IV.—Given the observed angles D and E only.

Case 1.—D and A being acute.

$$x = 2a + d.$$

Case 2.—When either D or A is obtuse.

$$x = 2a - d, \text{ when } a \text{ exceeds } d;$$

$$x = d, \text{ when } d \text{ exceeds } a.$$

It is almost superfluous to remark, that the logarithmic differences are treated in the notation as common numbers.

The following list contains for every triangle of which all the angles have been observed, the difference of their sum and 180°.

—0' 1"	—0' 28"	—0' 41"	—1' 4"	—2' 6"	+0' 42"
0 4	0 29	0 42	1 6	+0 14	0 44
0 13	0 30	0 42	1 10	0 21	0 58
0 14	0 30	0 47	1 25	0 21	1 29
0 17	0 35	0 55	1 27	0 31	1 29
0 27	0 39	1 2	1 28	0 31	

Mean error 45", or 15" per angle.

Registers of the Measurement of the Horizontal Angles.

<i>At Shunnor Fell.</i>		Readings.	
	Readings.		
Water Crag	0° 0' 0"	Wildboar Fell	231° 59' 12"
Pickington Ridge	52 30 20	Pillar Hill	247 6 5
Bakestone Edge	61 5 42	<i>At Ingleborough.</i>	
Penhill	73 12 20	Whernside	36° 23' 6"
Lovely Seat	78 56 20	Shunnor Fell	63 59 40
G ^t Whernside (M)	99 4 20	Water Crag (M)	70 42 4
Settronside	101 2 56	Dod Fell	83 58 52
Bear's Head	119 1 37	Bear's Head	86 9 3
Ten End	133 31 30	Settronside	117 48 14
Pen-y-gent (C)	134 45 16	G ^t Whernside (M)	130 10 28
Dod Fell	135 43 47	Pen-y-gent	135 43 10
Ingleborough	157 39 3	<i>At Whernside.</i>	
Knoutberry Hill	162 58 15	Ten End	4° 27' 23"
Whernside	167 5 18	Bear's Head	10 44 18
The Sayls	212 22 18	Dod Fell	15 39 17
Swarth Fell	218 25 10	Settronside	

	Readings.		Readings.
Setttronside	38° 51' 16"	Yockenthwaite	} 203° 34' 15"
G ^t Whernside (M)	48 5 8	Moor	
Pen-y-gent	70 56 56	Bear's Head	229 40 58
Ingleborough	119 52 33	Dod Fell	236 18 48
Wildboar Fell	308 31 0	Ten End	242 50 4
Shunnor Fell	336 55 52	Lovely Seat	291 16 2
Water Crag (M)	341 34 35	Shunnor Fell	305 53 30
Knoutberry Hill	343 17 51		
Whaw Fell	358 40 48		

At Bear's Head.

		Lovely Seat	8° 12' 20"
		Water Crag	21 45 58
		Bakestone Edge	37 6 18
		High Fleak	51 49 47
		Pickington Ridge	61 15 48
		Whitfield Hill	74 17 9
		Addleborough	83 33 48
		Penhill	97 3 16
		Harlen Fell	103 27 16
		Stake Fell	113 9 3
		Great Haw	114 54 19
		Wasset Fell	119 45 11
		Brownhaw	123 6 48
		Little Whernside	125 0 4
		Setttronside	136 43 18
		Yockenthwaite	} 152 11 27
		Moor	
		Pen-y-gent (C)	199 17 15
		Ingleborough	232 1 32
		Dod Fell	239 44 46
		Whernside	253 6 25
		Whaw Fell	261 51 49
		Knoutberry Hill	277 30 25
		Ten End	282 15 51
		Swarth Fell	314 31 17
		Wildboar Fell	320 49 35
		The Sayls	331 0 26
		Pillar Hill	337 2 44
		Shunnor Fell	351 13 16

At Bakestone Edge.

Water Crag	19° 42' 10"
Pickington Ridge	107 26 18
High Fleak	113 45 40
Penhill Beacon	138 36 35
Penhill	144 44 43
Little Whernside	165 52 15
Great Whernside	176 41 57
Addleborough	179 6 37
Setttronside	184 14 49
Stake Fell	188 6 40

At Pen-y-gent.

Ingleborough	54° 6' 15"
Whernside	85 50 7
Dod Fell	138 21 49
Shunnor Fell	139 28 19
Bear's Head	151 48 5

Yock-

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	Readings.		Readings.
Yockenthwaite } Moor	179° 33' 29"	Whernside	138° 51' 24"
Penhill	194 39 53	Knontberry Hill	182 41 42
Settronside	203 9 35	Shunnor Fell	248 46 2
Great Whernside	225 14 0	Penhill	330 52 7

At Penhill.

Brownhaw	4° 46' 3"
Settronside	17 43 6
Wasset Fell	26 2 37
Yockenthwaite } Moor	40 1 34
Stake Fell	51 51 37
Bear's Head	63 28 23
Addlebrough	74 0 9
Lovely Seat (misty)	90 36 3
Shunnor Fell (misty)	91 47 4*
Bakestone Edge	98 34 29
High Fleak	106 38 10
Pickington Ridge	124 38 50
Caldberg Moor	255 54 18
Rover Crag (C)	279 56 48
Great Haw (C)	302 26 57
Little Whernside	337 16 10
Great Whernside	347 17 39
Harlen Fell	359 10 25

At Dod Fell.

Settronside	0° 35' 32"
Great Whernside	8 36 39
Pen-y-gent	66 41 17
Ingleborough	110 40 58

At Little Whernside.

Settronside	157° 49' 5"
Bear's Head	178 21 2
Bakestone } Edge	(C) 206 38 28
Penhill	244 11 48
Penhill Beacon	254 3 8
Whitfield Hill	256 45 35
Rover Crag	286 27 3
Great Haw	307 59 30

At Rover Crag†.

Little Whernside	105° 45' 15"
Settronside	130 43 15
Harlen Fell	166 41 55
Penhill	186 10 45
Whitfield Hill	239 4 0
East Witton Fell	294 1 15

At the Great Haw†.

Little Whernside	44° 19' 41"
Settronside	61 47 15
Brownhaw	69 28 30
Wasset Fell	78 59 0
Bear's Head	84 35 0
Penhill	125 42 45
Penhill Beacon	139 39 7

Calculation of the mean Distances.

<i>Bases from the Ordnance Survey.</i>	<i>Feet.</i>
I. Shunnor Fell to Whernside	63377
II. ————— Ingleborough	82397
III. ————— Water Crag	35705
IV. ————— Great Whernside	91758
V. Ingleborough to Whernside	22435
VI. ————— Water Crag	116216
VII. ————— Great Whernside	85598
VIII. Whernside to Water Crag	98502
IX. ————— Great Whernside	89915

* Rejected in the calculation of the distance from Shunnor Fell to Penhill.

† At Rover Crag and Great Haw the theodolite was placed exactly over the centre of the signal.

Shunnor

Shunnor Fell to Settronside.

	Feet.
By Shunnor Fell and Whernside	70957
_____ Ingleborough	70965
_____ Water Crag	70931
Mean	70953

Water Crag to Settronside.

By Water Crag and Shunnor Fell	85304
_____ Ingleborough	85327
_____ Whernside	85313
Mean	85315

Whernside to Settronside.

By Whernside and Shunnor Fell	73489
_____ Ingleborough	73506
_____ Water Crag	73513
_____ G ^t Whernside	73467
Mean	73491

Ingleborough to Settronside.

By Ingleborough and Shunnor Fell	73410
_____ Whernside	73428
_____ Water Crag	73414
_____ G ^t Whernside	73409
Mean	73411

Shunnor Fell to Bear's Head.

By Shunnor Fell and Ingleborough	35613
_____ Whernside	35625
_____ Water Crag	35581
_____ Settronside	35632
Mean	35617

Water Crag to Bear's Head.

By Water Crag and Ingleborough	61502
_____ Whernside	61467
_____ Shunnor Fell	61430
_____ Settronside	61466
Mean	61460

Whernside to Bear's Head.

By Whernside and Ingleborough	47609
_____ Shunnor Fell	47626
_____ Water Crag	47619
_____ Settronside	47621
Mean	47619

Ingleborough to Bear's Head.

By Ingleborough and Whernside	58910
_____ Shunnor Fell	58933
_____ Water Crag	58950
_____ Settronside	58914
Mean	58923

Settronside to Bear's Head.

	Feet.
By Settronside and Ingleborough	38690
_____ Whernside	38672
_____ Water Crag	38667
_____ Shunnor Fell	38659
Mean	38676

Shunnor Fell to Bakeston Edge.

By Shunnor Fell and Water Crag	26333
_____ G ^t Whernside	26291
_____ Settronside	26330
_____ Bear's Head	26327
Mean	26326

Water Crag to Bakestone Edge.

By Water Crag and Shunnor Fell	32548
_____ Bear's Head	32536
Mean	32543

Great Whernside to Bakestone Edge.

By G ^t Whernside and Shunnor Fell	72853
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Settronside to Bakestone Edge.

By Settronside and Shunnor Fell	53508
_____ Bear's Head	53524
Mean	53517

Bear's Head to Bakestone Edge.

By Bear's Head and Shunnor Fell	31077
_____ Water Crag	31090
_____ Settronside	31100
Mean	31084

Shunnor Fell to Pen-y-gent.

By Shunnor Fell and Ingleborough	78500
_____ Whernside	78505
_____ G ^t Whernside	78499
Mean	78502

Ingleborough to Pen-y-gent.

By Ingleborough and Shunnor Fell	32168
_____ Whernside	32157
_____ Bear's Head	32154
Mean	32160

Whernside to Pen-y-gent.

By Whernside and Shunnor Fell	42097
_____ G ^t Whernside	42094
_____ Ingleborough	42090
_____ Bear's Head	42085
Mean	42092
Great	

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<i>Great Whernside to Pen-y-gent.</i>		Feet.
By G ^t Whernside and Shunnor Fell	53668	
Whernside	53680	
Mean	53676	

<i>Bear's Head to Pen-y-gent.</i>		
By Bear's Head and Ingleborough	45258	
Whernside	45250	
Mean	45254	

<i>Settronside to Pen-y-gent.</i>		
By Pen-y-gent and G ^t Whernside	43933	
Shunnor Fell	43933	
Bear's Head	43944	
Whernside	43944	
Mean	43938	

<i>Great Whernside to Settronside.</i>		
By G ^t Whernside and Whernside	21015	
Ingleborough	20985	
Pen-y-gent	20991	
Mean	20993	

<i>Shunnor Fell to Dod Fell.</i>		
By Shunnor Fell and G ^t Whernside	42182	
Whernside	42167	
Ingleborough	42166	
Settronside	42166	
Bear's Head	42163	
Mean	42168	

<i>Ingleborough to Dod Fell.</i>		
By Ingleborough and Shunnor Fell	46055	
Settronside	46048	
Pen-y-gent	46068	
Whernside	46068	
Mean	46060	

<i>Whernside to Dod Fell.</i>		
By Whernside and Shunnor Fell	35083	
Settronside	35087	
Ingleborough	35095	
Pen-y-gent	35096	
Mean	35090	

<i>Pen-y-gent to Dod Fell.</i>		
By Pen-y-gent and G ^t Whernside	36326	
Settronside	36337	
Ingleborough	36354	
Whernside	36356	
Mean	36343	

<i>Bear's Head to Dod Fell.</i>		Feet.
By Bear's Head and Settronside	13014	
Shunnor Fell	13022	
Mean	13018	

<i>Settronside to Dod Fell.</i>		
By Settronside and Ingleborough	43506	
Whernside	43497	
Shunnor Fell	43499	
Bakestone Edge	43496	
Pen-y-gent	43485	
Bear's Head	43498	
Mean	43497	

<i>Bakestone Edge to Dod Fell.</i>		
By Bakestone Edge and Settronside	43398	

<i>Great Whernside to Dod Fell.</i>		
By G ^t Whernside and Shunnor Fell	63159	
Pen-y-gent	63148	
Mean	63154	

<i>Shunnor Fell to Penhill.</i>		
By Shunnor Fell and Pen-y-gent	72176	
Bear's Head	72171	
Settronside	72185	
Dod Fell	72148	
Mean	72170	

<i>Bear's Head to Penhill.</i>		
By Bear's Head and Shunnor Fell	53800	
Settronside	53821	
Bakestone Ed.	53841	
Pen-y-gent	53800	
Mean	53816	

<i>Bakestone Edge to Penhill.</i>		
By Bakestone Edge and Settronsi.	46773	
G ^t Whernside	46797	
Bear's Head	46788	
Mean	46786	

<i>Pen-y-gent to Penhill.</i>		
By Pen-y-gent and Shunnor Fell	77287	
Dod Fell	77320	
Bear's Head	77292	
Mean	77300	

<i>Dod Fell to Penhill.</i>		
By Dod Fell and Shunnor Fell	64623	
Settronside	64660	
Pen-y-gent	64660	
Mean	64648	

Great

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<i>Great Whernside to Penhill.</i>		Feet.
By G ^t Whernside and Settronside	41388	
————— Bakestone	41378	
————— Edge	41378	
Mean	41383	

<i>Settronside to Penhill.</i>		
By Settronside and Shunnor Fell	34459	
————— Bear's Head	34462	
————— BakestoneEd.	34481	
————— G ^t Whernside	34490	
————— DodFell	34467	
Mean	34472	

<i>Bear's Head to Little Whernside.</i>		
By Bear's Head and BakestoneEdge	58851	
————— Penhill	58850	
————— Settronside	58847	
Mean	58849	

<i>Penhill to Little Whernside.</i>		
By Penhill and Bear's Head	27642	
————— Settronside	27642	
————— Bakestone Edge	27656	
Mean	27647	

<i>Bakestone Edge to Little Whernside.</i>		
By Bakestone Edge & Bear's Head	65539	
————— Settronside	65540	
————— Penhill	65562	
Mean	65547	

<i>Settronside to Little Whernside.</i>		
By Settronside and Bear's Head	22402	
————— BakestoneEd.	22412	
————— Penhill	22413	
Mean	22409	

<i>Bear's Head to Great Haw.</i>		
By Bear's Head and Settronside	70107	
————— Penhill	70117	
Mean	70112	

<i>Penhill to Great Haw.</i>		
By Penhill and Bear's Head	25080	
————— Settronside	25078	
Mean	25079	

<i>Settronside to Great Haw.</i>		
By Settronside and Bear's Head	37098	
————— Penhill	37117	
Mean	37115	

<i>Great Haw to Little Whernside.</i>		Feet.
By Little Whernside and Penhill	15966	
— Penhill to Great Haw	15961	
Mean	15964	

<i>Penhill to Rover Crag.</i>		
By Penhill and Settronside	18846	
————— Little Whernside	18853	
Mean	18850	

<i>Settronside to Rover Crag.</i>		
By Settronside and Penhill	41465	
————— Lit. Whernside	41460	
Mean	41463	

<i>Little Whernside to Rover Crag.</i>		
By Lit. Whernside and Penhill	23600	
————— Settronside	23591	
Mean	23596	

<i>Rover Crag to Caldberg Moor.</i>		
By Rover Crag and Penhill	10315	

<i>Penhill to Caldberg Moor.</i>		
By Rover Crag and Penhill	24101	

<i>Settronside to Caldberg Moor.</i>		
By Rover Crag and Penhill	51430	

<i>Penhill to Harlen Fell.</i>		
By Penhill and Rover Crag	6360	
————— Bear's Head	6356	
Mean	6358	

<i>Bear's Head to Harlen.</i>		
By Bear's Head and Penhill	51380	

<i>Rover Crag to Harlen.</i>		
By Rover Crag and Penhill	18734	

<i>Bear's Head to Wasset Fell.</i>		
By Bear's Head and Settronside	37719	
————— Penhill	37720	
Mean	37720	

<i>Penhill to Wasset Fell.</i>		
By Penhill and Bear's Head	23948	
————— Great Haw	23952	
Mean	23950	

<i>Settronside to Wasset Fell.</i>		
By Settronside and Great Haw	11315	
————— Bear's Head	11312	
Mean	11314	
<i>Bear's</i>		

<i>Bear's Head to Brownhaw.</i>		Feet.
By Bear's Head and Penhill		46179
Great Haw		46169
Mean		46174

<i>Penhill to Brownhaw.</i>		
By Penhill and Bear's Head		23740
Great Haw		23737
Mean		23738

<i>Little Whernside to Penhill Beacon.</i>		
By Little Whernside & Bake- stone Edge	}	31131
Great Haw		
Mean		31115

<i>Bakestone Edge to Penhill Beacon.</i>		
By Bakestone Edge and Little Whernside	}	50038

<i>Great Whernside to Penhill Beacon.</i>		
By calculation		46592

<i>Bear's Head to Whitfield Hill.</i>		
By Bear's Head and Settronside		74385
Lit. Whernside		74311
Mean		74337

<i>Settronside to Whitfield Hill.</i>		
By Settronside and Bear's Head		66079
Rover Crag		66004
Mean		66034

<i>Shunnor Fell to Pickington Ridge.</i>		
By Shunnor Fell and Settronside		48679
Bear's Head		48692
Penhill		48678
Mean		48683

<i>Bakestone Edge to Pickington Ridge.</i>		
By Bakestone Edge and Settronside		22980
Bear's Head		22990
Penhill		23001
Mean		22990

<i>Bear's Head to Pickington Ridge.</i>		
By Bear's Head and Settronside		47513
Shunnor Fell		47514
Bakestone Ed.		47512
Penhill		47498
Mean		47509

<i>Penhill to Pickington Ridge.</i>		Feet.
By Penhill and Settronside		31725
Shunnor Fell		31709
Bear's Head		31707
Bakestone Edge		31719
Mean		31715

<i>Settronside to Yockenthwaite Moor.</i>		
By Settronside and Pen-y-gent		18562
Bear's Head		18570
Bakestone Edge		18563
Penhill		18563
Mean		18564

<i>Bear's Head to Yockenthwaite Moor.</i>		
By Bear's Head and Settronside		21834
Pen-y-gent		21834
Bakestone Ed.		21832
Penhill		21846
Mean		21836

<i>Bakestone Edge to Yockenthwaite Moor.</i>		
By Bakestone Edge and Settronside		44937
Bear's Head		44926
Penhill		44945
Mean		44936

<i>Penhill to Yockenthwaite Moor.</i>		
By Penhill and Settronside		45059
Bear's Head		45048
Bakestone Edge		45078
Mean		45062

<i>Settronside to Stake Fell.</i>		
By Settronside and Bear's Head		19679
Penhill		19677
Mean		19678

<i>Bear's Head to Stake Fell.</i>		
By Bear's Head and Settronside		23281
Bakestone Ed.		23279
Mean		23280

<i>Penhill to Stake Fell.</i>		
By Penhill and Settronside		32117
Bakestone Edge		32126
Mean		32122

<i>Bakestone Edge to Stake Fell.</i>		
By Bakestone Edge & Bear's Head		34046
Penhill		34058
Mean		34052

<i>Bear's Head to Addlebrough.</i> Feet.		<i>Bear's Head to Knoutberry Hill.</i> Feet.	
By Bear's Head & Bakestone Edge	24192	By Bear's Head and Shunnor Fell	27905*
Penhill	24159	<i>Shunnor Fell to Knoutberry Hill.</i>	
Mean	24175	By Bear's Head and Shunnor Fell	38598*
<i>Penhill to Addlebrough.</i>		<i>Great Whernside to Knoutberry Hill.</i>	
By Penhill and Bakestone Edge	30836	By calculation	82426
Bear's Head	30843		
Mean	30840	<i>Bear's Head to Whaw Fell.</i>	
<i>Bakestone Edge to Ten End.</i>		By Bear's Head and Whernside	
By Bakestone Edge & Shunnor Fell	35800		27993*
Bear's Head	35793	<i>Shunnor Fell to Lovely Seat.</i>	
Mean	35797	By Shunnor Fell and Bear's Head	12396
<i>Bear's Head to Ten End.</i>		Bakestone Ed.	12382
By Bear's Head and Shunnor Fell	8975	Mean	12390
Bakestone Edge	8974	<i>Bakestone Edge to Lovely Seat.</i>	
Mean	8975	By Bakestone Edge and Shun-	} 15027
<i>Shunnor Fell to Pillar Hill.</i>		nor Fell	
By Shunnor Fell and Bear's Head	14247	Bear's Head	15023
<i>Bear's Head to Pillar Hill.</i>		Settronside	15050
By Shunnor Fell and Bear's Head	45798	Mean	15033
<i>Shunnor Fell to the Sayls.</i>		<i>Penhill to Lovely Seat.</i>	
By Shunnor Fell and Bear's Head	13426	By Penhill and Settronside	59875
Settronside	13420	Bear's Head	59852
Mean	13423	Mean	59863
<i>Bear's Head to the Sayls.</i>		<i>Settronside to Lovely Seat.</i>	
By Bear's Head and Shunnor Fell	38790	By Settronside and Penhill	59652
<i>Shunnor Fell to Wildboar Fell.</i>		Bakestone Edge	59683
By Shunnor Fell and Whernside	30208	Mean	59667
Bear's Head	30192	<i>Bear's Head to Lovely Seat.</i>	
Mean	30200	By Bear's Head and Shunnor Fell	27326
<i>Bear's Head to Wildboar Fell.</i>		Bakestone Edge	27340
By Bear's Head and Whernside	54951	Penhill	27296
Shunnor Fell	54946	Mean	27321
Mean	54948	<i>Penhill to High Fleak.</i>	
<i>Shunnor Fell to Swarth Fell.</i>		By Penhill and Bear's Head	38218
By Shunnor Fell and Bear's Head	30693	Bakestone Edge	38235
Settronside	30679	Mean	38226
Mean	30686	<i>Bear's Head to High Fleak.</i>	
<i>Bear's Head to Swarth Fell.</i>		By Bear's Head & Bakestone Edge	36846
By Shunnor Fell and Bear's Head	50670	Penhill	36829
<i>Great Whernside to Swarth Fell.</i>		Mean	36838
By calculation	110096	<i>Bakestone Edge to High Fleak.</i>	
		By Bakestone Edge & Bear's Head	10413
		Penhill	10415
		Mean	10414

[To be continued.]

* See Phil. Mag. and Annals, vol. iii. pages 94, 95.

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