

Survey of Craig Wen

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The Team:

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1) Introduction

Craig Wen (Section 30B, OS 1:50000 Map 115, Grid Ref. SH597508) is classed as a double subHewitt, that is it, just fails to make that list both on the height criterion (609.6m) and the drop criterion (30m). The OS 1:50,000 map gives the height of Craig Wen as 608m and drop was measured as 25m a few years ago by Myrddyn Phillips who used a simple staffing method. There is a small but finite chance that Craig Wen could exceed 609.6m in which case it would be added to the Nuttall's list of 2000ft mountains. If it were found to exceed both 609.6m and have a drop of 30m or greater, then it would also be eligible for addition to the Hewitts list, while having a drop of 30m but failing to achieve 609.6m in height would make Craig Wen eligible for Michael Dewey's list of hills.

The purpose of this survey was to measure accurately the height of Craig Wen using differential GPS and to measure the drop by both differential GPS and line survey. This work would then give a definitive answer on the status of the hill and the two drop measurements would enable GPS and line survey methods to be compared.

The survey took us close to Yr Aran and time permitted us to make a measurement of the height of this summit also and compare our result with that given by OS for a bench mark on the summit.

2) Equipment used and Conditions for Survey

Ground surveys to determine the positions of the bwlch and summit were carried out using a Leica NA730 Professional Automatic level (X30 telescopic system)/tripod system and a "1m" E-staff extendable to 5m.

Absolute heights were measured using a Leica Geosystems 530 GPS receiver. It is a dual-frequency, 24 channel instrument, which means it can lock on to a maximum of 12 satellites and receive two signals (at different frequencies) from each of these satellites. The latter feature reduces inaccuracies that result from atmospheric degradation of the satellite signal. As a stand alone instrument it is capable of giving position and height to an accuracy of about one to two metres respectively. Note that a hand-held GPS receiver can only receive up to 12 satellites and each at a single frequency and therefore it has a poorer positional accuracy of +/-5m and a height accuracy of no better than 10 metres. Despite the on-board features of the 530 GPS receiver, there are still sources that create residual errors. To obtain accurate positions and heights, corrections were made to the GPS data via imported RINEX data from the Ordnance Survey which was post-processed using Leica Geo Office Version 6 software.

Conditions for the survey, which took place between 10.30hr and 15.00hr, were fair. The weather was warm, 15 degrees Celsius, and sunny and the wind was moderate at 20 -25mph during the early and middle part of the day subsiding to less than 10mph later in the afternoon.

3) The Survey

3.1) Character of Hill

Craig Wen is situated on the SW ridge of Yr Aran just North of the village of Beddgelert. The easiest approach is from Rhyd Ddu along an excellent track that leads to the bwlch between Yr Aran and Snowdon. Just before the bwlch a stile over a fence leads to an indistinct path that contours south-east beneath Craig Wen and gives easy access to the summit and the bwlch between Craig Wen and Yr Aran. The ascent is on short grass for most of the way. Both the summit and the bwlch are well-defined and the terrain from bwlch to summit is also short grass and rock, thus enabling good staff placements for a line survey.

3.2) Summary of Survey Method

The position of the bwlch was identified as a narrow strip of ground by a fence that runs SE to NW across the bwlch. Having identified the area of the bwlch, a detailed survey was next carried out to locate its exact position. The level was set up at a convenient place on the South side of the bwlch, and then a line of points marked by small flags was laid down in a NW – SE direction at a distance that was obviously on the higher NE side of the bwlch. The highest of these, as measured by the level, was marked with a different coloured flag. Next a second parallel line was marked out 1m nearer the level and again the highest point identified by the level and marked with a different coloured flag. This process was repeated until there was a line of flags that was clearly on the SW side of the bwlch. The resulting array of flags, with a line of different coloured ones marking the highest points of each line, gave a very clear picture of the geography of the bwlch. By surveying the highest points of each line and determining the lowest of these the position of the bwlch was fixed to within about 2m.

The summit of the hill required only cursory measurement with level and staff in order to identify the highest point.

The absolute heights of the summit and the bwlch were measured with the Leica 530GPS. The instrument was set up with tripod support to hold it firmly over the point to be measured. The AT502 antenna was mounted directly on to a small tripod for the summit determination at a height of 0.377m above the summit rock. For the bwlch the AT502 antenna was mounted on a 1m pole. Data for the summit were collected for 2hr and for the bwlch 30min, each with an epoch time of 5 seconds.

3.3) The Bwlch

The bwlch was surveyed with level and staff as described in Section 3.2 and we are confident this was achieved to within +/-0.1m of height.

The ten-figure Grid References for the bwlch were:-

Garmin Map60CSx	SH 59897 51176	Accuracy 4m Height = 583m
Garmin Venture	SH 59897 51176	Accuracy 6m Height = 580m
Garmin Etrex	SH 59896 51175	Accuracy 7m Height = 579m
Magellan Explorist 100	SH 59894 51178	Accuracy 9m Height = 582m

The position and height data for the bwlch that were recorded by the Leica 530 and post-processed with Leica GeoOffice using imported OS RINEX data from the five nearest OS Active Base Stations were:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
SR 530	259894.790	0.002	351173.740	0.002	579.563	0.013

3.4) Summit of Craig Wen

The exact position of the summit, although obvious, was checked with the level and staff and is a rock under the small cairn.

The ten-figure Grid References for the summit were:-

Garmin Map60CSx	SH 59712 50850	Accuracy 4m	Height = 606m
Garmin Venture	SH 59710 50849	Accuracy 6m	Height = 604m
Garmin Etrex	SH 59710 50852	Accuracy 6m	Height = 601m
Magellan Explorist 100	SH 59711 50850	Accuracy 5m	Height = 614m

The position and height data for the summit recorded by the Leica 530 and post-processed with Leica GeoOffice using imported OS RINEX data from the five nearest OS Active Base Stations were:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
SR 530	259707.251	0.003	350847.373	0.002	604.880	0.011

The drop from the summit to the bwlch calculated from the GPS measurements is $604.880 - 579.563 = 25.317\text{m}$.

3.5) The Line-survey

The line survey from the summit of Craig Wen to the bwlch was carried out using the method described in previous reports. The results are given in Table 1 where the drop is measured to be $25.3 \pm 0.1\text{m}$.

3.6) Summit of Yr Aran

The summit of Yr Aran is a rock outcrop that supports the cairn. This outcrop also holds an OS rivet, the coordinates for which are given on the OS website. These are E 260437.953, N 351526.813 and height 747.064m. The data provide a check for our measurements, although the coordinates were last measured in 1979. The actual summit is a rock on the far side of the cairn from the rivet and it is 0.131m higher. The AT502 antenna was mounted directly on to a small tripod for the summit determination at a height of 0.495m directly above the rivet. Data were collected for 30min with an epoch time of 5sec.

The ten-figure Grid References for the summit are:-

Garmin Map60CSx	SH 60441 51532	Accuracy 4m	Height = 752m
Garmin Venture	SH 60442 51532	Accuracy 5m	Height = 743m
Garmin Etrex	SH 60440 51533	Accuracy 5m	Height = 744m
Magellan Explorist 100	SH 60442 51533	Accuracy 6m	Height = 747m

The position and height data for the summit rivet recorded by the Leica 530 and post-processed with Leica GeoOffice using imported OS RINEX data from the five nearest OS Active Base Stations were:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
SR 530	260437.959	0.003	351526.829	0.003	747.062	0.003

The height of the actual summit of Yr Aran is therefore $747.062 + 0.131 = 747.193\text{m}$.

These results are in excellent agreement with the OS results. East and North coordinates differ by 0.006 and 0.016m respectively and the heights agree to 0.002m.

4) Discussion of Results

The largest error was associated with the correct location of the bwlch which gives an uncertainty of $\pm 0.10\text{m}$ in its height. We also estimate that the summit height was measured to better than $\pm 0.04\text{m}$ and the line survey also has a similar precision. Therefore the overall error in drop measurement for the hill is no more than $\pm 0.11\text{m}$.

The drop measurement was found to be: $25.3 \pm 0.1\text{m}$ (GPS) and $25.3 \pm 0.1\text{m}$ (line survey) and therefore Craig Wen does not achieve the 30m required to give it Hewitt or Dewey status. Note the excellent agreement between GPS and line survey measurements.

5) Summary and Conclusions

The **summit of Craig Wen** is at grid reference * SH 59711 50850 and is a rock beneath the small cairn. Its height is **$604.88 \pm 0.04\text{m}$** .

The bwlch separating Craig Wen from Yr Aran is at grid reference * SH 59896 51176. Its height is **$579.6 \pm 0.10\text{m}$** .

The **re-ascent from the bwlch to the summit is 25.3m** and therefore the **Craig Wen is not promoted to any of the lists of hills.**

The height of **Yr Aran** was found to be **747.2m** in excellent agreement with the height given by OS.

* NB average hand-held Garmin/Magellan GPS grids are quoted in the summary.

John Barnard and Graham Jackson, 10 April 2009.

Title:- Survey of Craig Wen

Instrument:- Leica NA370 Automatic level **Date:- 02/04/2009**

Point Number	Horizontal Line		Lower Stadia Line		Upper Stadia Line		Height Difference metres
	Backsight BS metres	Foresight FS metres	Backsight BS metres	Foresight FS metres	Backsight BS metres	Foresight FS metres	
Survey from Summit to bwich (Level JB, Staff GJ, and data collection MP)							
1	0.357	1.995	0.344	1.834	0.372	2.158	1.996
2	1.514	3.436	1.290	3.306	1.736	3.566	3.436
3	0.583	4.878	0.548	4.810	0.617	4.950	4.879
4	0.297	3.253	0.265	3.196	0.330	3.310	3.253
5	0.517	4.448	0.492	4.371	0.544	4.529	4.449
6	0.944	2.095	0.926	1.868	0.963	2.321	2.095
7	0.835	2.782	0.804	2.645	0.865	2.918	2.782
8	0.615	3.359	0.572	3.286	0.658	3.430	3.358
9	0.778	2.038	0.765	1.822	0.793	2.256	2.039
10	1.324	3.038	1.185	2.848	1.465	3.231	3.039
11	0.693	2.004	0.676	1.907	0.716	2.099	2.003
12	0.997	1.443					1.443
						SUM =	34.772
							-25.314