Survey of Craig y Penmaen

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The Team:

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1) Introduction

Craig y Penmaen (Hill 7544, Section 30D, OS 1:50000 Maps 124, OS 1:25000 Map 18W, Grid Ref SH724299) is listed as a sub HuMP with a drop of 99m. (A HuMP is any hill in England, Scotland, Wales, Isle of Man and Ireland with a minimum drop of 100m). The OS 1:25000 map shows a spot height of 420m at the summit and using interpolation of contours the height of the bwlch is estimated to be 321m. Consequently there is a significant chance that the drop could be greater than 100m thereby promoting this hill to the main HuMP list.

The purpose of this survey was to locate and measure accurately the heights of the bwlch and summit of Craig y Penmaen in order to clarify its status.

2) Equipment used and Conditions for Survey

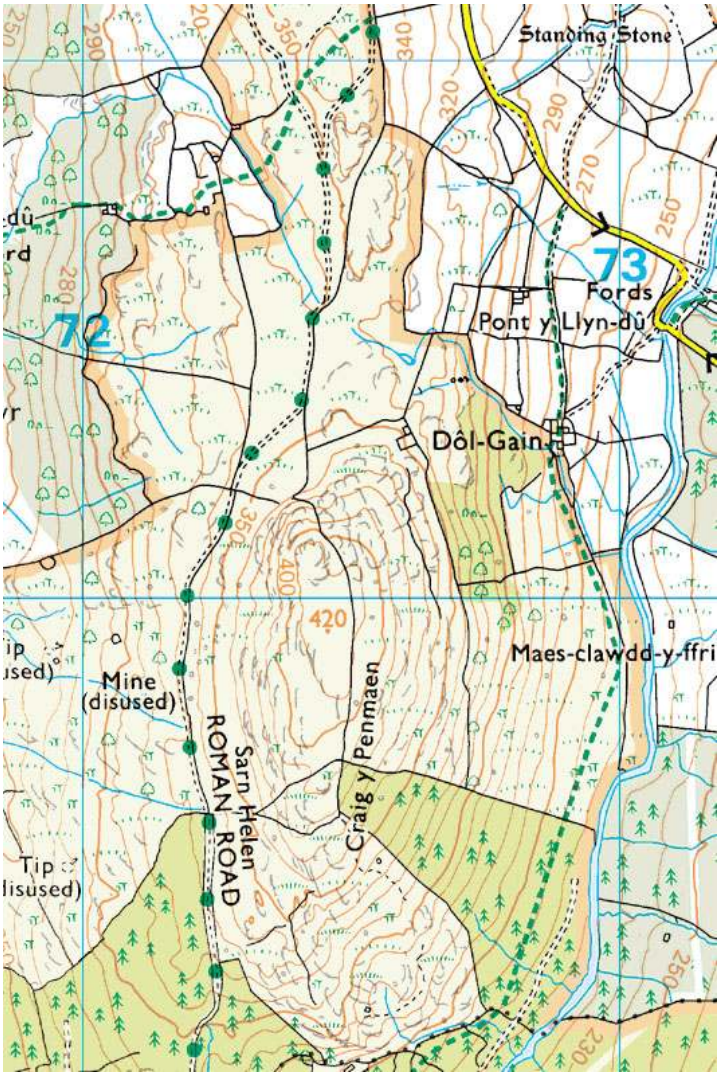
Ground surveys to determine the positions of the bwlch and summit were carried out using a Leica NA730 Professional Automatic level (X30 telescopic system)/tripod system and a "1m" **E**-staff extendable to 5m.

Absolute heights were measured using a Leica Geosystems Viva GS15 Professional receiver. This instrument is a dual-frequency, multi-channel instrument, which means it is capable of locking on to a maximum of 12 GPS and 8 GLONASS satellites as availability dictates, 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 signals. As a stand-alone instrument it is capable of giving position and height to an accuracy of about two metres and five metres respectively. Note that small hand-held GPS receivers used for general navigation can only receive up to 12 GPS satellites and each at a single frequency and therefore these instruments have a poorer positional accuracy of +/-5metres and a height accuracy of no better than +/-10 metres. Some recently produced hand held GPS Garmin receivers can also receive signals from GLONASS satellites which greatly improve the speed at which these units can achieve a satellite "fix". Despite the on-board features of the Viva GS15 receiver, there are still sources that create residual errors. To obtain accurate positions and heights, corrections were made to the GNSS (Global Navigation Satellite System) data via imported RINEX data from the Ordnance Survey which were post-processed using Leica Geo Office 8.3 software for the GS15 data.

Conditions for the survey, which took place between 11.00hr and 16.00hr GMT, were fair. The weather was a little cloudy at first but with good sunny periods. The temperature was about 5 degrees Celsius. During the day the cloud increased from the West and by the end of the survey it was just starting to rain lightly, the wind had increased and the temperature had started to fall.

2.1) Character of Hill

Craig y Penmaen is a shapely hill that lies about 1km East of the A470 and just North of the Coed y Brenin Forest Mountain Biking Centre. The OS maps mark the summit with a spot height of 420m and this hill has an excellent 360 degree panoramic view of mountains from Snowdonia to Cader Idris. Despite is low altitude, the ascent of Craig y Penmaen is not straightforward. Both the West and East sides of the hill are steep and access is barred by craggy outcrops. Access is best gained from the North where there is parking on the verge of the minor road not far from the cattle grid. The Roman Road is followed South until a stone wall is reached which leads up the North ridge of Craig y Penmaen. It is possible to follow the edge of the wall, with some short scrambly sections, until the summit plateau is reached. This area is quite extensive and covered with thick heather. There are also a number of points that are contenders for the summit position.



2.2) Summary of Survey Method

The survey commenced at the summit where there were a number of points that were contenders for the highest point. Visually, and confirmed using an Abney level, the options were narrowed down to two possible points. Finally the summit position was found using Leica NA730 level and staff to be on heathery ground adjacent to a cairn. GNSS data were then collected with the Leica GS15 supported over this point.

Next the survey moved to the bwlch. The presence of a stream running off the watershed in both the valley to valley directions simplified the identification of the area containing the bwlch. Staff readings were taken with the Leica NA730 level along this line and the position of the bwlch was identified. That was confirmed with further staff readings taken in the transverse direction. Finally the Leica GS15 was set up on a tripod over this point and GNSS data were collected.

2.3) The Summit

Although the flanks of Craig y Penmaen are quite steep and rocky, the summit area of the hill is a heather and grass plateau with a number of distinct high points. Visually it was clear that some of these points were lower. However, these points were viewed systematically through an Abney level from the most northerly contender and it was clear that there were two possibilities for the highest point that were about 20m apart. One of these points was marked with a cairn. The Leica NA730 automatic level was setup on a tripod at a convenient position near this cairn and set so that it was level with the base of it. All other points were confirmed to be lower. Finally staff readings were taken around this cairn until the highest ground was found. We estimated that we had located the summit position to a height uncertainty within +/-0.05m.

The Leica GS15 was then setup on the short tripod over the summit position. The vertical offset measured on the tape was 0.420m. GNSS data were collected for 1 hour with an epoch time of 15 seconds. (See photographs in Appendix for summit and vertical offset).

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

Garmin Montana 600	SH 72467 29953	Height = 422m
Garmin Etrex 20	SH 72465 29954	Height = 427m
Garmin Oregon 450	SH 72465 29954	Height = 428m

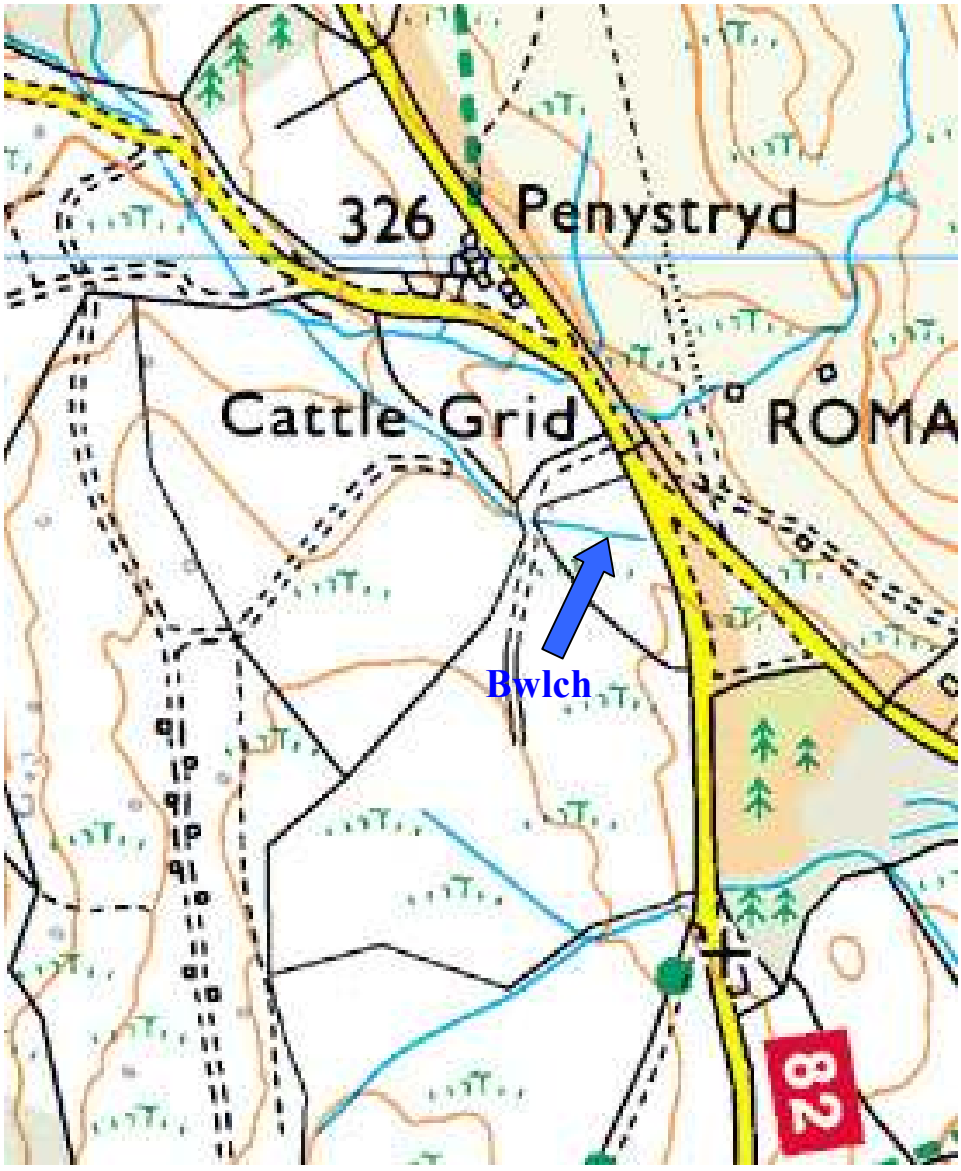
The position and height data for the summit that were recorded by the Leica Viva GS15 was post-processed with Leica GeoOffice 8.3 using imported OS RINEX data for the seven nearest base stations and the Hopfield model for tropospheric correction. These results are given in the table below:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	272461.861	0.001	329948.298	0.002	419.261	0.012

The height of the Craig y Penmaen is 419.26m

2.4) The Bwlch

An extract from the OS 1:25000 map of the area in the region of the bwlch is shown below. Visually the bwlch appears to lie in a fenced area of very boggy ground to the West of the minor road. The hill to hill direction runs at right angles to the road. A track leads from the road in a South West direction and crosses over a small stream which is culverted under the track. As the stream at this point is flowing to the North West, then the ground to the South East that is in the valley to valley direction must be higher. In fact this stream visually appears to follow the line of the bwlch in the valley to valley direction. The Leica NA730 level was setup on a tripod on the West side of this stream and staff readings were taken at regular intervals of about 10m along the West Bank. The area was very flat for about 50 metres before the ground descended into a steeper gully. Staff readings were also taken in the transverse direction and these confirmed that the bank of the stream was indeed the valley to valley line of the bwlch. The position of the bwlch is marked on the map below. Since this area was very boggy and covered with thick tussock grass we estimated that it was possible only to locate the bwlch to a height uncertainty of +/-0.3m.



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

Garmin Montana 600	SH 72594 31805	Height = 321m
Garmin Etrex 20	SH 72593 31805	Height = 321m

The Leica GS15 was set up directly over the bwlch on the "Short tripod" system with a measured vertical offset of 0.574m. Data were collected for 1 hour with an epoch time of 15 seconds. (See photographs in Appendix for bwlch and vertical offset).

The position and height data for the summit that were recorded by the Leica Viva GS15 and post-processed with Leica GeoOffice 8.3 using imported OS RINEX data for the seven nearest base stations and the Hopfield model for tropospheric correction are given in the table below.

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	272586.689	0.001	331801.488	0.003	321.511	0.014

The height of the bwlch is therefore 321.51m

3) Summary of Operating and Process Conditions

	GS15
Data Collection bwlch (min)	65
Data collection summit (min)	64
Number of Base Stations used in Processing for all points	7
Epoch Time (sec)	15
Tropospheric Model	Hopfield
Cut off Angle (degs)	15

4) Discussion of Results

The drop for Craig y Penmaen is 419.26 – 321.51 = 97.75m and therefore Craig y Penmaen remains a sub-HuMP. The dominating uncertainty in the drop measurement is the height uncertainty associated with the location of the bwlch which we estimated to be +/-0.3m. Therefore, the drop is 97.8 +/-0.3m.

The uncertainties in the height measurement taken by the GS15 for the summit are +/-0.05m associated with its location and +/-0.05m for the GNSS 1 hour data set. This gives an overall uncertainty in the summit height of +/-0.08m.

Because of the large uncertainty in the position of the bwlch it is appropriate to record its grid references to 8 figures rather than 10 as written in the Summary below.

5) Summary and Conclusions

The **summit** of **Craig y Penmaen** is at grid reference * SH 72467 29954 and is unfeatured ground next to the cairn. Its height is **419.26+/-0.08m**.

The **bwlch** for Craig y Penmaen is at grid reference *SH 7259 3180. Its height is **321.5+/-0.3m**.

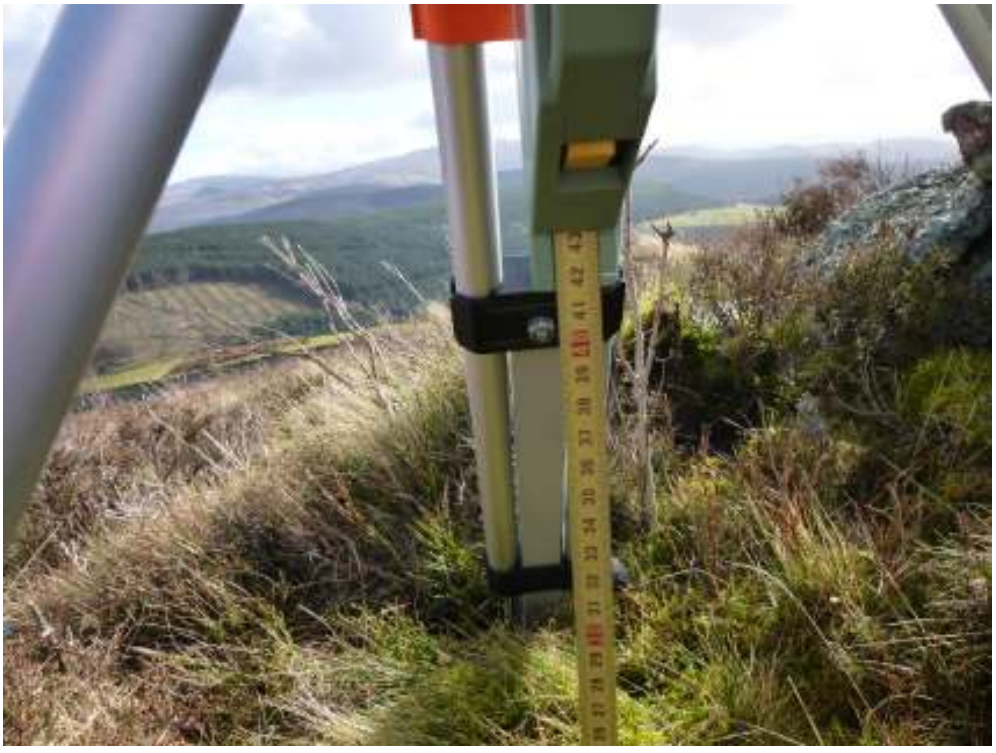
The **re-ascent** from the **bwlch to the summit is 97.8m** and therefore **Craig y Penmaen remains a sub-HuMP.**

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

John Barnard and Graham Jackson 13 April 2014.

Appendix

View of GS15 set-up at summit on short tripod



Summit - GS15 Vertical offset at 0.420m

Leica GS15 setup at bwlch on short tripod

Bwlch - GS15 vertical offset at 0.574m