

Survey of Mynydd Anelog

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The Team:

John Barnard, Graham Jackson, Myrddyn Phillips, Chris Watson and, Enid and Jeff Parr.

1) Introduction

Mynydd Anelog (Hill 1960, Section 30A, OS 1:50000 Map 123, OS 1:25000 Maps 253, Grid Ref. SH151272) is situated at the western end of the Llyn Peninsula (Pen Llŷn) in Gwynedd. It is listed as having a drop of 149m and therefore is classified as a sub Marilyn. (A Marilyn is any hill in England, Scotland, Wales, Isle of Man and Ireland with a minimum drop of 150m). Recent map studies have suggested that the drop does in fact exceed 150m and therefore there is an excellent chance that this hill will be promoted to Marilyn status.

The purpose of this survey is to measure accurately the heights of the summit and bwlch in order to determine if the drop for Mynydd Anelog exceeds 150m.

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 is a dual-frequency, multi-channel instrument, which means it can lock on to a maximum of 12 GPS and 8 GLONASS 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 two metres and five metres respectively. Note that a hand-held GPS receiver can only receive up to 12 GPS 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. 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 GPS data via imported RINEX data from the Ordnance Survey which was post-processed using Leica Geo Office 8.3 software.

Conditions for the survey, which took place between 09.00hr and 15.00hr, were excellent. The weather was clear, with a light breeze on the summit, brilliant sunshine and a temperature of ca. 25 Degrees Celsius. It made a nice change to be able to sunbathe while the GPS was collecting data!

2.1) Character of Hill

Mynydd Anelog is almost at the western extremity of the Llyn peninsular. It is on the coastline and to the West the summit of the hill drops down to the sea cliffs. Most of Mynydd Anelog is owned by the National Trust. The summit area is a splendid view point with Bardsey Island to the West and in the distance the hills of Snowdonia to the East. A minor road runs in a North/South direction to the East of the hill and about 0.5km from it at the nearest point. A number of footpaths from this road give easy access over grassy terrain to the summit although car parking is generally rather limited.

The critical bwch lies about 2km to the North East of the summit in agricultural land. Permission was sought from the land owner, John Parri at Carreg Farm, to survey on his land, and this was kindly granted. Furthermore, he cleared the relevant field of cattle to allow us to carry out the survey of the bwch without being hindered by inquisitive animals!



2.2) Summary of Survey Method

The first objective for the survey was to locate the exact position of the bwch. The surrounding area is very flat and visually it was quite difficult to ascertain the slope of the land. The spot height of 41m shown on the large scale map places the bwch position at the corner of a fence (shown by the arrow in the map above). However, the land to the East, which is in the hill to hill direction, appeared to be lower indicating that the bwch position should be further to the East. The exact position of the bwch was obtained by taking measurements from a grid of flags set out in a square matrix across the area surrounding the bwch. The Leica GS15 was set up at a point a few metres from the bwch with the antenna on a 2.000m pole. Data were collected for 1 hour with an epoch time of 15 seconds.

The survey then moved to the summit of the hill. The automatic level was set up on the tripod at a convenient point from the cairn and staff readings were taken at potential high points. It soon became clear that the highest point was either a rock about 4m distant from the cairn or a rock buried within the cairn. Consequently, the cairn was mostly dismantled and the rock about 4m from it was found to be 0.02m higher than any fixed rock within the cairn. The cairn was then rebuilt and left as we found it. The Leica GS15 was set up on the “short tripod” system directly over the highest point and data were collected for 1 hour with an epoch time of 15 seconds.

2.3) The Bwlch

As discussed in Section 2.2 the location of the bwlch was not obvious and seemed to be further East from where the spot height on the large scale map suggested it should be. A square matrix of flags was laid out with the flags about 25m apart. Although land to the East of the position of the spot height appeared to be lower, the staff measurements showed this not to be the case and in fact the actual bwlch was very close to the position of the spot height. Before this could be confirmed, we had to check the ground to the West of a dyke and ditch that ran in a NNE to SSW direction near the bwlch and formed a field boundary. A visual inspection of the ditch showed that water in it was running in a SSW direction indicating that the bwlch lay in an area just to the South of the fence corner or just to the North of it. Next the automatic level was set up on a tripod on top of the dyke and staff readings were taken either side of the dyke. These readings proved that the ground was indeed falling away in a SSW direction and, as expected, rising in a westerly direction (the hill to hill direction). Ground immediately on the West side of the fence near the corner was about 0.3m lower than on the East side. The survey identified the position of the bwlch to be on the East side of the fence and about 20m South of the fence corner. However, it should be noted that ground up to 100m NNE was within 0.3m in height of the bwlch position and that the general unevenness of the ground in this area was +/-0.2m. Our work showed that the dyke did not lie on the bwlch itself and therefore should not be considered further.

A photo of the GPS set up is shown in the Appendix.

The eight-figure Grid References recorded at the GPS measurement position, which was about 25m West of the position of the bwlch, were:-

Montana 600	SH 1734 2894	Accuracy <5m	Height = 47m
Garmin Map60CSx	SH 1734 2894	Accuracy <5m	Height = 36m
Garmin Etrex 20	SH 1734 2894	Accuracy <5m	Height = 46m
Magellan Explorist 100	SH 1734 2894	Accuracy 6m	Height = 47m
Garmin Oregon 450	SH 1734 2894	Accuracy 4m	Height = 50m

The position and height data for the set up position for the bwlch that were recorded by the Leica Viva GS15 and post-processed with Leica GeoOffice 8.3 using imported OS RINEX data from the eight nearest OS base stations and the Hopfield tropospheric model were:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	217335.946	0.001	328937.061	0.001	40.558	0.008

Staff reading at GPS set up position = 0.650m

Staff reading at bwlch = 0.845m

Height of bwlch = $40.558 + 0.650 - 0.845 = 40.36\text{m}$

Because of the unevenness in the ground around the bwlch we estimate from the variation in staff readings around this point an uncertainty of about +/-0.3m in the absolute height measurement.

2.4) The Summit

See photos in Appendix

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

Montana 600	SH 15198 27221	Accuracy <5m	Height = 191m
Garmin Map60CSx	SH 15198 27222	Accuracy <5m	Height = 189m
Garmin Etrex 20	SH 15199 27223	Accuracy <5m	Height = 193m
Magellan Explorist 100	SH 15198 27221	Accuracy 7m	Height = 199m
Garmin Oregon 450	SH 15203 27223	Accuracy 4m	Height = 200m

The Leica GS15 vertical offset used for the antenna mounted on the “Short Tripod” was measured by the integral tape to be 0.461m in addition to the 0.255m vertical offset associated with the tribrach/hook and clamp system. 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 from the eight nearest OS base stations and Hopfield tropospheric model were:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	215193.956	0.002	327218.256	0.001	191.390	0.007

The height of the summit is 191.39m

3) Discussion of Results

Since the position of the hill’s summit could be identified precisely, the main error associated with measurement is that associated with the GPS measurement itself for 1 hour of data collection. We would estimate this uncertainty to be +/-0.06m. However, by far the most significant error for the measurement of the height of the bwlch and hence the calculation of the drop arises from the height uncertainties in the bwlch location. As already stated, we have estimated this uncertainty to be +/- 0.3m from staff measurements made in this area. The calculated drop from the measurements is 151.0+/-0.3m and therefore exceeds the minimum 150m required for Marilyn status.

4) Summary and Conclusions

The **summit of Mynydd Anelog** is at grid reference * SH 15199 27222 and is the top of an embedded rock. Its height is **191.39+/-0.06m**.

The critical **bwlch** for **Mynydd Anelog** is at grid reference *SH 1734 2894. Its height is **40.4+/-0.3m**.

The **drop from the summit to bwlch** is **151.0+/-0.3m** and therefore **Mynydd Anelog** is **reclassified from sub Marilyn to Marilyn**.

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

John Barnard, Graham Jackson, Myrddyn Phillips 11 August 2013.

Appendix

Leica Viva GS15 set up near the bwlch of Mynydd Anelog



Locating the summit of Mynydd Anelog



Leica Viva GS15 set up on the summit of Mynydd Anelog



Tape reading (0.461m) for Short Tripod setup GS15 on summit

