Survey of Garreg-hir

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The Team:

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1) Introduction

Garreg-hir (Section 31A, OS 1:50000 Map 136, Grid Ref. SN998977) is listed as a marginal Marilyn with 151m of drop. The summit is thought to be the trig point which is marked on the map with a height of 485m. However, there is at least one other point to the north of the trig point that may be higher than its base. There are two possible positions for the bwlch at Grid Refs SH924031 and SH941027, approximately 7km and 9km respectively North-West of the summit and both are partially covered with coniferous forest.

The purpose of this survey was to locate the positions of the summit and bwlch and measure their heights accurately in order to determine the drop and therefore the status of Garreg-hir.

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, 12-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 and five 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 7 software.

Conditions for the survey were good. The bwlch was surveyed between 10.00 and 15.00hrs. The wind was very light, visibility excellent and the temperature about 10 degrees Celsius. The summit was surveyed between 16.00 and 18.00hrs. Visibility was excellent and the temperature was about 8 degrees Celsius, but the strong breeze created significant wind-chill.

3) The Survey

3.1) Character of Hill

Garreg-hir is situated about 3km North East of the A470 and about 6.5km North-West of the village of Caersws. The lower western flanks of Garreg-hir are quite steep but the gradient eases towards the summit. The top of the hill consists of a distinct North to South ridge, about 500m in length and guarded on both sides by broken crags. Access to the hill, which involves just over 1km of distance and about 80m of ascent, is very easily gained via footpaths from the minor road running in a North South direction to the East of the hill.

The two candidate bylchau each lie about 2km North East of the A470. Access to them can be gained from minor roads that leave the A470 at Dolfach and Talerddig respectively. For the more North-Westerly bwlch at the end of the minor road from Dolfach, a footpath passes in a West to East direction South of the bwlch, but the bwlch itself is on private land. The LDP, the Glyndwr Way, also passes about 500m South of the bwlch. A complication is that the bwlch lies in a partially forested area and indeed it may just lie within the trees. The second candidate bwlch lies just 400m North-West of the minor road that connects Talerddig to Llanerfyl. This area too is partially covered with forestry and therefore the bwlch itself may also be in trees. This increases the complexity of the survey and indeed could make an accurate survey impossible.

3.2) Summary of Survey Method

Careful study of the map suggests that the candidate bwlch at SH941027 is probably higher than that at SH924031. It is therefore more likely that the latter is the critical bwlch. We thus argued that if this latter bwlch were surveyed first and if it indeed then proved that Garreg-hir had more than 150m of drop, there would be no need to survey the second bwlch. In this situation measurement of the second bwlch could only change the drop value, but not the status of the hill. Consequently, the survey concentrated on what we believed to be the lower of the two bwlchau at SH924031. It was carried out in two distinct parts. Firstly, the position of the bwlch was identified by visual inspection and then with detailed surveying with level and staff. Since it was not possible to set up the GPS over the bwlch position, because of the tree cover, a suitable position was identified about 40m away. A height correction was then made between the two positions, using the level and staff, to obtain the height of the bwlch. Secondly, having relocated to the top of Garreg-hir, the summit position was identified with level and staff and then its height measured by GPS.

Absolute heights were measured with the Leica 530 GPS unit. The instrument was set up with tripod support to hold it firmly over the point to be measured. The AT502 Antenna was mounted on a 2.000m pole for both the bwlch and summit measurements. Data at each point were collected for 1hour with an epoch time of 30 seconds. The data were post-processed using Leica GeoOffice 7 with RINEX data downloaded from the OS website for the eight nearest Active Stations.

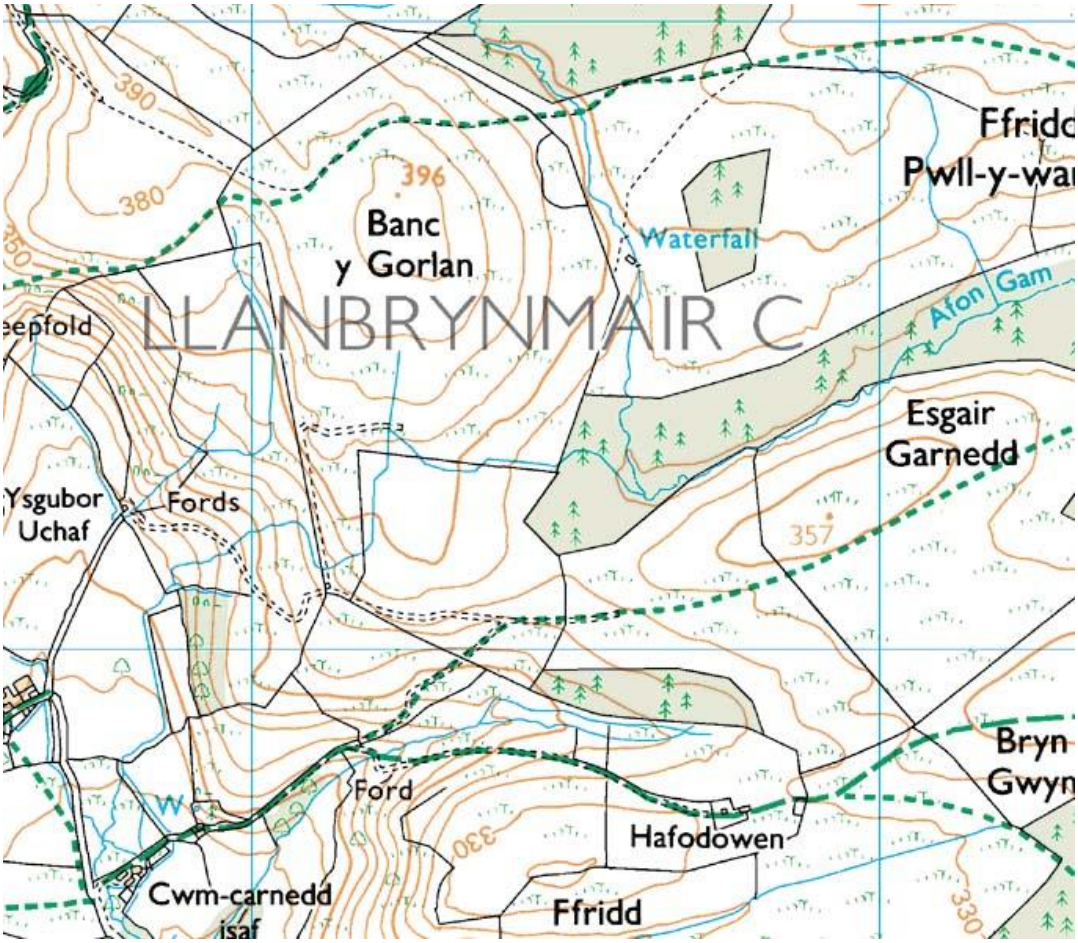
3.3) The Bwlch

The detail for the bwlch of Garreg-hir is shown below in an extract from the Ordnance Survey 1:25000 scale map. The hill to hill direction runs from Banc y Gorlan in the north, but as the bwlch position is approached to the South the hill to hill line turns in an easterly direction to the summit of Esgair Garnedd. As can be seen from the map, forest covers most of the northern area of the bwlch itself and this made it impossible to obtain by visual inspection a good general picture of the bwlch's contours, so that the area requiring more detailed surveying could be identified. Not marked on the map, but just to the West of the forest edge at the bwlch, there is a small artificially created pond, the banks of which complicate the topography.

The first step in locating the bwlch's position was to decide if it lay within or outside the forest. Unfortunately we could not use the level and staff inside the forest because of the density of tree cover. We had to adopt a more qualitative approach here and we found that the direction of flow of water in the drainage ditches under the trees enabled us to determine the slope of the land. After spending an hour or more on this process, we were all confident that the position of the actual bwlch lay just outside the forested area. Every time we entered the trees from a different point to examine the slope of the land, we were taken back to the same area just on the edge of the trees as the area in which the bwlch lay.

Having now located the approximate position of the bwlch, we set up four parallel lines of flags in a West North West to East South East direction. The flags were placed approximately 2 metres apart.

Having set up the level on the tripod at a convenient position, so that all the flags were visible from it, we systematically took staff readings for each flag, there being about 20 measurements in total. All the staff measurements lay between 1.40m and 1.75m. From these data we were able to locate the bwlch's position as ground by the t-junction of a drainage ditch.



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

Garmin Map60CSx	SH 92476 03186	Accuracy 3m	Height = 339m
Garmin Venture	SH 92474 03184	Accuracy 4m	Height = 341m
Garmin Etrex	SH 92473 03184	Accuracy 5m	Height = 340m
Magellan Explorist 100	SH 92473 03184	Accuracy 6m	Height = 344m

As stated earlier, this position was too near to the tree canopy to allow us to set up the GPS and take a height measurement. Therefore we set up the GPS about 30m to the South and 5m to the West of the bwlch in a position that was well away from the trees. (A photograph of this position is shown in Appendix 1).

The ten-figure Grid References recorded for the GPS set-up position were:-

Garmin Map60CSx	SH 92469 03157	Accuracy 4m	Height = 338m
Garmin Etrex	SH 92469 03153	Accuracy 6m	Height = 340m

In order to make the necessary height correction between the GPS set-up position and the bwlch, staff readings were taken from both points.

Staff reading at GPS set-up position = 1.049m

Staff reading at bwlch = 1.298m

Bwlch is 0.249m LOWER than the GPS set-up position.

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 were:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
SR 530	292465.771	0.002	303150.513	0.002	334.419	0.007

Therefore the height of the bwlch is 334.419-0.249 = 334.170m.

3.4) Summit of Garreg-hir

The detail for the bwlch of Garreg-hir is shown below in an extract from the Ordnance Survey 1:25000 scale map. The key feature of the summit is the long narrow ridge that extends in a South East to North West direction with a trig point positioned nearer to its northern end. The ground clearly rises from the South East up to the trig point and then flattens to the north of it for about 150m before descending. There is a distinct high point on the ridge about 120m away from the trig point.

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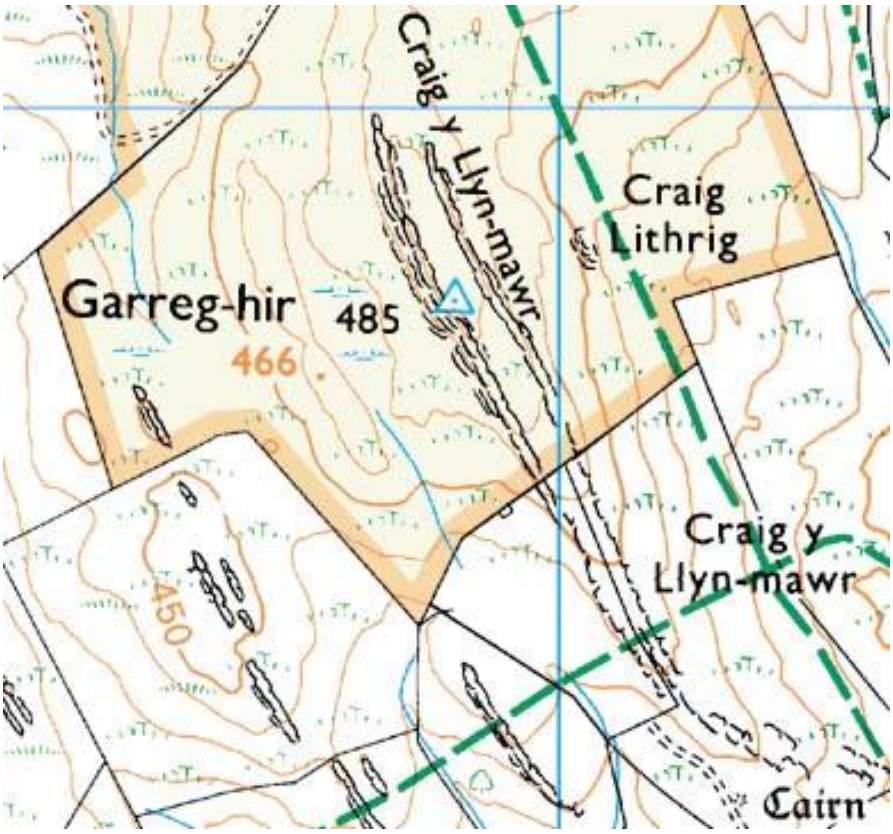

The automatic level was set up near the trig point and staff readings were taken around it to find the highest point in this area. We found this to be the top of a rock about 10m SSE of the trig point. Staff measurements were then taken along the ridge to the North on potential summit positions. The exact summit position was identified as the top of unfeatured ground about 120m distant from the trig point. The following staff readings were recorded:-

Staff reading at flush bracket on trig point = 0.159m

Staff reading at top of rock 10m SSE of trig point = 0.385m

Staff reading at summit position = 0.275m

Trig point flush bracket is HIGHER than summit by 0.275-0.159 = 0.116m

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

Garmin Map60CSx	SN 99873 97921	Accuracy 3m	Height = 486m
Garmin Venture	SN 99872 97920	Accuracy 5m	Height = 490m
Garmin Etrex	SN 99871 97921	Accuracy 5m	Height = 486m
Magellan Explorist 100	SN 99871 97921	Accuracy 6m	Height = 490m

The position and height data for the summit recorded by the Leica 530 and post-processed with Leica GeoOffice using imported OS RINEX data were:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
SR 530	299868.840	0.002	297915.756	0.001	484.873	0.005

The Ordnance Survey database quotes the flush bracket height on the trig point as 484.94m compared with our measurement of 484.87 + 0.12 = 484.99m.

4) Discussion of Results

The drop for Garreg-hir is 484.87 – 334.17 = 150.7m and therefore this hill retains its classification as a Marilyn as it meets the drop criterion for this list.

The largest error for this survey was associated with the correct location of the bwlch and we would estimate an uncertainty in the height for this as +/-0.20m. We also estimate that the uncertainty in the measurement of the summit height was +/-0.10m. Therefore the overall error in the drop measurement for the hill is about +/-0.22m.

There is excellent agreement between our measured height for the flush bracket on the trig point and that from the OS Database. The two values differ by only 5cm.

Having established that this bwlch confirms the Marilyn status of Garreg-hir we concluded there was no need, as reasoned above, to survey the second candidate bwlch.

5) Summary and Conclusions

The **summit** of **Garreg-hir** is at grid reference *** SN 99872 97921** and is on unfeatured ground 120m North of the trig point. Its height is **484.9+/-0.1m**. This point is 0.11m higher than the top of the rock 10m SSE of the trig point.

The **bwlch** is at grid reference ***SH 92474 03184**. Its height is **334.2+/-0.2m**.

The **drop** from the **summit to the bwlch is 150.70+/-0.22m** and therefore **Garreg-hir retains its Marilyn status.**

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

John Barnard and Graham Jackson, 07 December 2011

Appendix 1

GPS set-up position to survey bwlch. View looking South East.

GPS set-up on the Summit of Garreg-hir. View looking North