Survey of Moel y Gyrafolen

22 February 2013

The Team:

John Barnard, Graham Jackson and Myrddyn Phillips

1) Introduction

Moel y Gyrafolen (Hill 3381, Section 30D, OS 1:50000 Map 124, OS 1:25000 Map 18W, Grid Ref. SH672352) is situated in the Rhinogydd about 2km West of the south western corner of Llyn Trawsfynydd. In July 2000 Myrddyn Phillips carried out a survey of this hill and using his levelling technique measured a drop of 100ft / 30.5m. As a result of this survey, Moel y Gyrafolen was added to Michael Dewey's list of 500m hills.

The purpose of this survey was to find the positions of the summit and bwlch, to measure their heights accurately and from the calculated drop determine if Moel y Gyrafolen should retain its Dewey 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 Viva GS15 receiver. This 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 two metres 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 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 v7.01 software.

Conditions for the survey, which took place between 11.00hr and 15.30hr GMT, were satisfactory with broken cloud and good visibility. However, it was bitterly cold, -4 degrees Celsius, and the effect of the cold was enhanced by a significant chill factor from the wind which we estimated to be blowing between 15 and 20mph. These weather conditions were a major factor that prevented us carrying out a line survey to support the GPS measurements.

3) The Survey

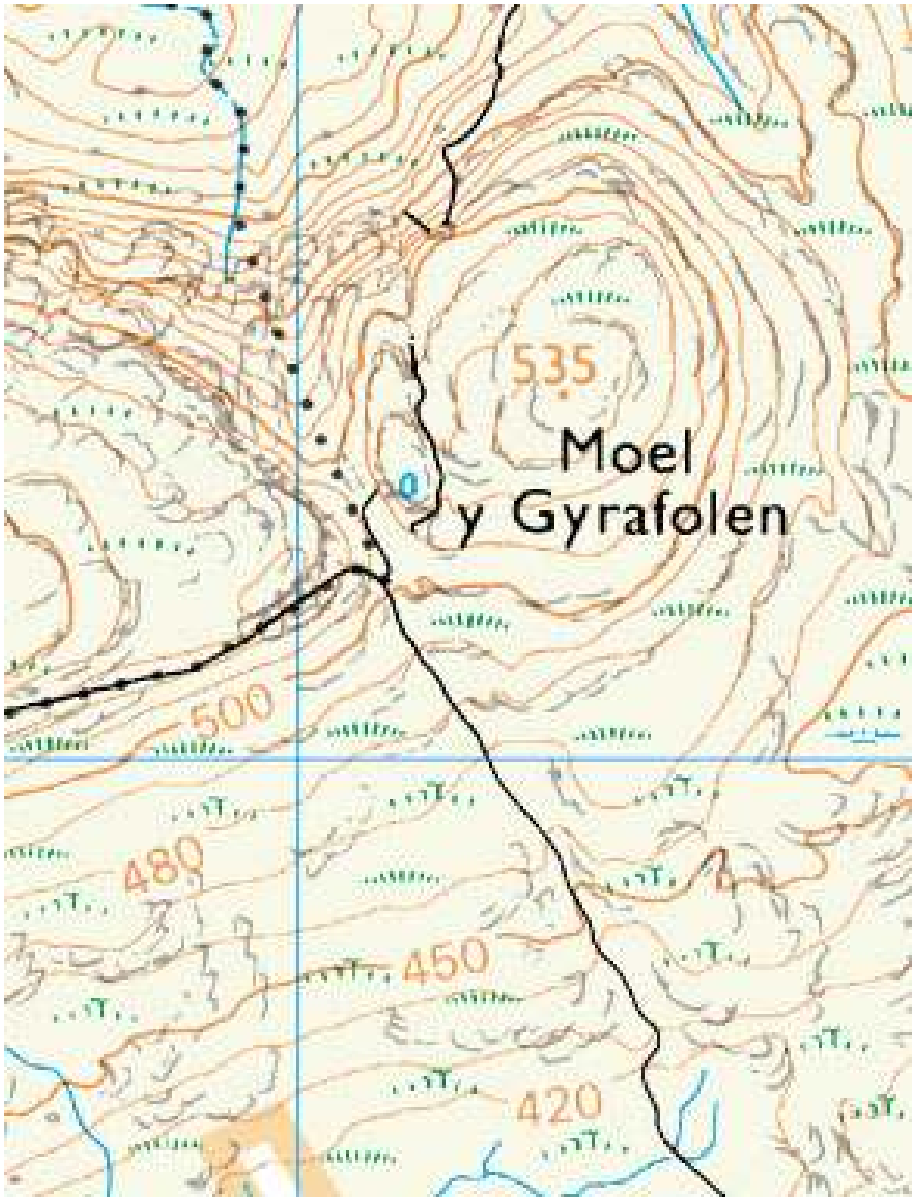
3.1) Character of Hill

Moel y Gyrafolen can easily be reached from the ends of the minor roads that start from the A470 and run around the southern end of Llyn Trawsfynydd. The minor road that holds the bank of Llyn Trawsfynydd terminates near a farm called Moelfryn where there is a small free car park but donations in the box to Air Rescue are appropriate. From there, it is necessary to retrace one's steps along the road to join the footpath that leads to the bwlch between Moel y Gyrafolen and Craig y

Gwynt to the North. From there, faint paths continue South up steep broken ground to the hill's summit. It is also possible to access this hill from the end of the minor road terminating at Cefn Clawdd. This reduces the amount of ascent by just less than 100m, but parking on this road is very limited and permission may need to be sort from the farm at the end of the road.

The summit area is quite flat and consists of grass with rock outcrops. However the sides of the hill, particularly the upper slopes, are steep and one has the feeling of climbing into wild terrain. Moel y Gyrafolen is the second significant hill after Craig y Gwynt at the northern end of the long North to South ridge that encompasses a number of hills known as the Rhinogydd. Most of the ridge is wild and rocky and to traverse the full length of the ridge is a serious undertaking.

The critical bwlch to the South West of the summit is quite narrow and rocky with steep sides. A high wall, protected by substantial barbed-wire fencing, crosses the bwlch in a valley to valley direction but a stile allows access to both sides of the wall. These details are shown in the extract from the 1:25000 Ordnance Survey map shown below.



3.2) Summary of Survey Method

The survey commenced on the summit plateau of the hill. The level was set up on its tripod at a convenient point so that staff readings could be taken from all possible summit positions. The summit position, which had previously been identified using an Abney level, was confirmed as the top of a rock. Since it was not possible to place a tripod over this point, the Leica Viva GS15 was set up on a tripod, using the tribrach, adaptor and optical plummet system, a few metres away at a convenient and more sheltered point. This point had been levelled to the summit of the hill. Data were collected for 1 hour with an epoch time of 15 seconds.

Next the survey continued at the bwlch. The valley to valley and hill to hill directions are obvious and the bwlch area is visually well defined. However it is complicated by a high stone wall that runs in the valley to valley direction on the opposite side of the bwlch to Moel y Gyrafolen before turning to the hill to hill direction on its North Western side. The first task here was to identify on which side of the wall the bwlch was positioned. This was done by setting up the level on the side of Moel y Gyrafolen with sufficient height so that staff readings could be taken either side of the wall. (See photograph in Appendix and map above). The higher ground, and hence the position of the bwlch, was identified as being on the East side of the wall. Then a grid of white flags was set out in a square matrix, aligned in the hill to hill direction, with a flag spacing of 2m until all of the survey area had been covered. Staff readings were then taken successively at each flag on each line of flags in the hill to hill direction. The highest staff reading, lowest point, for each line of flags was replaced with a yellow flag. Finally the position of the bwlch is then identified as the lowest staff reading, highest point, of the line of yellow flags in the valley to valley direction.

We did not set up the Leica Viva GS15 GPS at the critical bwlch as this area in relation to its surroundings is narrow and satellite reception would have been obstructed by the sides of Moel y Gyrafolen and Foel Penolau. Instead we set up the GPS about 40m SSE of the bwlch position having previously levelled to this point. Once again the GPS was mounted on the tripod via the tribrach, adaptor and optical plummet system and data were collected for 1 hour with an epoch time of 30 seconds.

3.3) The Summit

The summit was identified as the top of a rock and a photograph of this is shown in the Appendix. The following staff readings were recorded.

Staff reading at summit = 0.435m

Staff reading at cairn = 2.398m

Staff reading at an alternative high point (rocky knoll) = 0.870m

Staff reading at GPS setup position = 1.923m

Vertical Offset at GPS setup position = 0.601m (see confirmatory photo in the Appendix)

The cairn, 55m NE from the summit, was clearly lower and we confirmed the height difference to be 2.398 – 0.435 = 1.963m.

A rocky knoll, an alternative possibility for the summit and 30m South of it, was measured to be 0.870 – 0.435 = 0.435m lower.

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

Garmin Montana 600	SH 67219 35290	Accuracy 3m	Height = 537m
Garmin Map60CSx	SH 67218 35295	Accuracy 2m	Height = 534m

Garmin Oregon 450	SH 67218 35292	Accuracy 3m	Height = 535m
Garmin Etrex	SH 67218 35292	Accuracy 6m	Height = 536m

The ten-figure Grid References recorded for the rocky knoll were:-

Garmin Montana 600	SH 67220 35264	Accuracy 3m	Height = 536m
Garmin Map60CSx	SH 67219 35266	Accuracy 3m	Height = 532m
Garmin Oregon 450	SH 67221 35263	Accuracy 2m	Height = 537m
Garmin Etrex	SH 67221 35263	Accuracy 5m	Height = 538m

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

Garmin Montana 600	SH 67263 35325	Accuracy 3m	Height = 537m
Garmin Map60CSx	SH 67262 35329	Accuracy 4m	Height = 535m
Garmin Oregon 450	SH 67262 35326	Accuracy 3m	Height = 535m
Garmin Etrex	SH 67263 35325	Accuracy 3m	Height = 537m

The position and height data for the summit GPS setup position that were recorded by the Leica Viva GS15 and post-processed with Leica GeoOffice 7 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	267206.324	0.001	335291.631	0.002	535.259	0.003

The height of the summit is therefore 535.259 + 1.923 – 0.435 = 536.75m

3.4) The Bwlch

The immediate area around the bwlch was covered with tussock grass which limited the accuracy to which the exact position of the bwlch could be identified. However, from the variation in staff measurements taken in this area, we would estimate that we had located the bwlch position to within a height uncertainty of +/-0.1m.

The following staff readings were recorded:-

Staff reading at bwlch = 0.471m

Staff reading at GPS setup position = 2.858m

Vertical Offset at GPS setup position = 0.502m (see confirmatory photo in the Appendix)

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

Montana 600	SH 67067 35195	Accuracy 2m	Height = 511m
Garmin Map60CSx	SH 67064 35195	Accuracy 4m	Height = 505m
Garmin Oregon 450	SH 67067 35194	Accuracy 4m	Height = 515m
Garmin Etrex	SH 67065 35196	Accuracy 6m	Height = 514m

The position and height data for the bwlch GPS setup position that were recorded by the Leica Viva GS15 and post-processed with Leica GeoOffice 7 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	267078.719	0.002	335160.974	0.003	504.245	0.003

The height of the bwlch is therefore 504.245 + 2.858 – 0.471 = 506.63m

4) Discussion of Results

The height uncertainty for the location of the summit position, estimated at less than +/-0.01m, is small as the summit position being the top of a rock is easily identified and is reproducible. The largest uncertainty for this height measurement will be that for the GPS measurement itself, and for 1 hour of data previous work has shown this to be +/-0.06m. This means that the overall uncertainty in the height of Moel y Gyrafolen is estimated to be +/-0.06m.

The height of Moel y Gyrafolen is therefore measured to be 536.75+/-0.06m. This compares with 535m currently on the latest 1:25000 and 1:50000 scale OS Maps and is therefore within the OS measurement tolerance of +/-3m.

The largest height uncertainty of +/-0.1m, estimated from the unevenness of the terrain at the bwlch, combined with a +/-0.06m uncertainty in the GPS measurement leads to an overall uncertainty in the height of the bwlch of +/-0.12m. Therefore the height of the bwlch is 506.63+/-0.12m.

The calculated drop for Moel y Gyrafolen is 30.12 +/-0.13m and therefore this hill just makes the minimum 30m drop required to be in Michael Dewey's list of 500m high hills. This result compares well with Myrddyn Phillips's surveyed drop of 30.5m.

5) Summary and Conclusions

The **summit** of **Moel y Gyrafolen** is at grid reference *** SH 67218 35292** and is the top of a rock. Its height is **536.75+/-0.06m**.

The **bwlch** separating **Moel y Gyrafolen** from F**oel Penolau** is at grid reference ***SH 67066 35195**. Its height is **506.6+/-0.1m**.

The **drop** from the **summit to bwlch is 30.12+/-0.13m** and therefore **Moel y Gyrafolen retains its Dewey status.**

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

John Barnard, Graham Jackson, Myrddyn Phillips 23 February 2013.

Appendix

Locating the summit position

Detail (0.601m) showing Tape Measurement from Ground level for Leica GS15 set up to measure summit height

Locating the Bwlch Position

Detail (0.502m) showing Tape Measurement from Ground level for Leica GS15 set up to measure bwlch height