

Survey of Moel Tryfan

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The Team:

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1) Introduction

Moel Tryfan (Hill 5151, Section 30B, OS 1:50000 Map 115, OS 1:25000 Maps 17W/254, grid reference SH515561) is situated 3km due North of Nantlle and 2km North West of Mynydd Mawr in North Wales. It is listed as having a drop of 100m and therefore just qualifies for the list of one hundred metre prominence (HuMP) hills. It also qualifies as a thirty metre prominence hill (TuMP) and is listed in Y Pedwarau (previously entitled 'The Pedwars') (Welsh thirty metre prominence hills that are between 400m and 499m in height).

The purpose of this survey was to locate the positions of summit and bwlch and measure their heights accurately in order to determine if Moel Tryfan should retain its HuMP 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 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 from the GPS system, 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 Ordnance Survey which was post-processed using both Leica Geo Office v7.01 and Leica Geo Office v8.3 software.

Conditions for the survey, which took place between 11.00hr and 17.00hr, were perfect. It was warm (25 degrees Celsius) and sunny throughout the day. Moreover, the wind was light which enabled the staff to be extended to 5m when required without undue difficulty.

3) The Survey

3.1) Character of Hill

Moel Tryfan is easily accessed from the small village of Carmel which lies just to the East of the A487 about 8km South of Caernarfon. From Carmel a minor road runs for just over 1km East to the hamlet of Y Fron, where it terminates and a track may then be taken in a North East direction to the bwlch. This track continues beyond the bwlch and provides easy access to the summit of nearby Mynydd Mawr. A car may be taken for the first 300m from the road end at Y Fron along this track, where there is ample parking.

A small mound no more than 30-40m across and just a few metres high lies in the area of the bwlch and creates two possible locations, one just to the North West and one just to the South East of the mound, where the bwlch itself might lie. To the unaided eye the one to the South East appeared to be the lower.

From the bwlch it is but a short walk of just over 1km North West to the summit. This is mainly over short grass, but spoil heaps on the skyline hint at what is to come. The summit ridge is bisected by the remains of the Moel Tryfan and Alexandra quarry. Fortunately, an access road circumnavigates the declivity and on the far side lies the summit itself just ½ km away. It comprises a rock tor with a trig point on its northern side, and the pinnacle of the tor rises approximately 2m above the trig point.

A plaque at the foot of the tor informs the reader that Moel Tryfan was visited by Charles Darwin, who came to study the geology of the area and in particular the mudstones, of which the summit tor is made, that overlie the bed of slate.

3.2) Summary of Survey Method

The survey commenced at the bwlch and the first task was to determine in which of the two possible areas to the North West and South East of the mound the bwlch was located. To do this the level was set up on the summit of the mound and staff readings were taken at each location. It was quickly established that the North West area (staff reading 2.20m) was higher than the South East area (staff reading 5.2m) and therefore our effort was next concentrated on this South East area. Three lines of flags, 2m apart, were laid out perpendicular to the hill to hill direction over the bwlch and staff readings were taken at each point. This work quickly enabled the exact position of the bwlch to be established, as described in previous reports. It should be noted that a small and probably disused metal pipeline runs across the bwlch in the hill to hill direction. The pipe is about 15cm in diameter and is covered in earth and for a short distance forms the path to the summit of Mynydd Mawr. The overall height of this structure is about 0.4m and our located position for the bwlch is about 2m from it. This structure was not considered as part of the natural topography and was disregarded in the subsequent determination of bwlch height and drop. The Leica GS15 was set up over the bwlch position on a tripod using a Leica proprietary tribrach and optical plummet system and its height above the ground measured. Data were collected for 1 hour with an epoch time of 15 seconds.

The survey next moved to the summit where it was quickly established that setting up the GPS receiver on the summit tor was impracticable. Regrettably, there was no way of firmly anchoring a tripod to the small area of rock, so that we could guarantee its stability for the two hours of data collection we planned. Consequently we chose a position on a level area of grass about 4m from the trig point. In order to determine the height difference between the set up position and the summit of the tor, the level was put on a small tripod on the small area or rock available on the summit. This platform was stable and presented no danger to the equipment with one of the team in attendance. The height of the level's eyepiece above the summit rock of the tor was measured using a tape and then a staff reading was taken at the GPS set-up position. The difference yielded the height difference between the two locations. Staff readings were also taken between the GPS set-up position and the flush bracket of the trig point so that the flush bracket's height could be measured and checked against the Ordnance Survey database. The Leica GS15 was then set up on a tripod using a Leica proprietary tribrach and optical plummet system and its height above the ground measured. Data were collected for 2 hours with an epoch time of 15 seconds.

3.3) The Bwlch

Photographs of the GPS set up on the bwlch are shown in the Appendix.

The ten-figure Grid References recorded for the bwlch with hand-held GPS receivers were:-

Montana 600	SH 52648 55522	Height = 330m
Garmin Map60CSx	SH 52649 55522	Height = 322m
Etrex 20	SH 52647 55524	Height = 327m
Garmin Oregon 450	SH 52648 55524	Height = 333m
Magellan Explorist 100	SH 52649 55521	Height = 332m

All accuracies were between 2m and 4m

The Leica GS15 vertical offset used for the antenna mounted on the “Short Tripod” was measured by the integral tape to be 0.738m in addition to the 0.255m vertical offset associated with the tribrach/hook and clamp system. The position and height data for the bwlch that were recorded by the Leica Viva GS15 and post-processed with Leica GeoOffice 7.01 using imported OS RINEX data from the eight nearest OS base stations were:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	252644.009	0.004	355517.254	0.004	326.355	0.013

The height of the bwlch is therefore 326.355m

The data was also post-processed using GeoOffice 8.3 with additional data from the GLONASS satellites but this made less than 0.005m difference to the height result.

3.4) The Summit

Photographs of the GPS set up on the summit are shown in the Appendix.

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

Montana 600	SH 51533 56195	Height = 433m
Garmin Map60CSx	SH 51527 56199	Height = 422m
Etrex 20	SH 51534 56196	Height = 434m
Garmin Oregon 450	SH 51532 56194	Height = 437m
Magellan Explorist 100	SH 51532 56195	Height = 435m

All accuracies were between 2m and 4m

The staff readings to correct the height of the GPS data collection point to the summit were:-

Height of level above summit = 0.452m (measured with tape)

Staff Reading at GPS setup position = 2.867m

Staff readings to determine the flush bracket height were:

Flush bracket staff reading = 0.238m

GPS set-up position staff reading = 0.557m

The Leica GS15 vertical offset used for the antenna mounted on the “Short Tripod” was measured by the integral tape to be 0.645m 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 7.01 using imported OS RINEX data from the eight nearest OS base stations were:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	251523.106	0.002	356189.593	0.001	426.572	0.007

The data was also post-processed using GeoOffice 8.3 with additional data from the GLONASS satellites but this made less than 0.005m difference to the height result.

The height of the summit is $426.572 + 2.867 - 0.452 = 428.987\text{m}$

The measured height of the flush bracket is $426.572 + 0.557 - 0.238 = 426.91\text{m}$

The height of the flush bracket given in the Ordnance Survey trig point database is 427.02m. Our value of 426.91 is in reasonable agreement with the OS value.

4) 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 2 hour of data collection. We would estimate this uncertainty to be +/-0.05m. 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. We estimate this uncertainty to be +/-0.1m from staff measurements made in this area, while that associated with 1hr data collection is +/-0.06m. The calculated drop from these measurements is 102.6+/-0.15m which exceeds the minimum 100m required for HuMP status.

5) Summary and Conclusions

The **summit** of **Moel Tryfan** is at grid reference * SH 51532 56196 and is the top of a rock pinnacle. Its height is **429.0+/-0.05m**.

The critical **bwlch** for **Moel Tryfan** is at grid reference *SH 52648 55523. Its height is **326.4+/-0.15m**.

The **drop** from the **summit to bwlch** is **102.6+/-0.15m** and therefore **Moel Tryfan retains its HuMP classification**.

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

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Appendix

Leica Viva GS15 set up on the bwlch of Moel Tryfan



Leica Viva GS15 set up showing vertical offset (0.738m) at the bwlch of Moel Tryfan



Measuring the height of the level on small tripod on summit tor of Moel Tryfan



Measuring the height difference between summit and Leica Viva GS15 set up position



Leica Viva GS15 set up on Moel Tryfan



Leica Viva GS15 set up showing vertical offset (0.645m) at the summit of Moel Tryfan

