

Fforest Fawr Geopark

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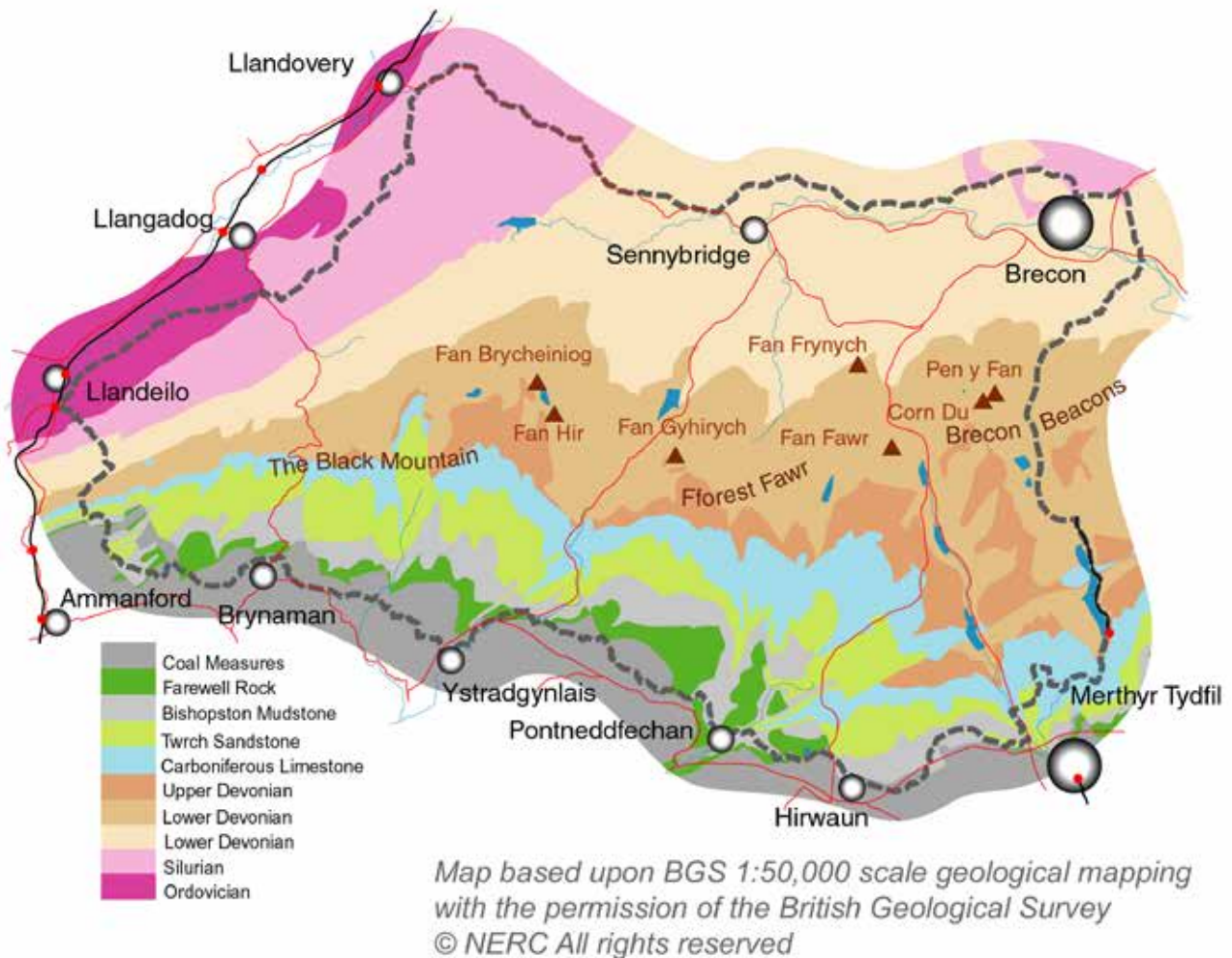


Fig. 1. A geological map of the Fforest Fawr Geopark. Copyright the British Geological Society.

In 2005, Fforest Fawr Geopark became the first geopark to be established in Wales. As of October 2013, it was one of 58 geoparks in Europe. The park has been sculpted by nearly 500myrs of geological history and contains the highest mountains in southern Britain, the deepest cave in Britain, the finest collection of waterfalls in Britain and 7,000 years of recorded human occupation.

The geopark lies wholly within the Brecon Beacons National Park, occupying the central and western part of the park.

Ordovician

The oldest rocks in the geopark are of Ordovician age (485 to 443mya). During this time, the geopark was very different from today. There was a great ocean known as the Iapetus separating England and Wales from Scotland, in which lived many marine creatures, such as graptolites and trilobites.

Ordovician rocks were deposited at the margins of the Iapetus Ocean

and outcrop in the extreme western portion of the geopark, between the towns of Llandeilo and Llandoverly (Fig. 1). The names of these towns may sound familiar to those who know something about stratigraphy, because they have been used to name stages within the Ordovician and Silurian periods. In fact, Wales as a whole has played a very major role in the naming of geological periods, with the earliest three periods since multicellular life began - the Cambrian, the Ordovician and the Silurian - all having Welsh origins.

The Cambrian Period was named after the Latin name for Wales, Cambria, by Adam Sedgwick; while the Silurian was named by Roderick Murchison in the 1830s after the Silures tribe who inhabited southern Wales in Roman times. Originally, there was no Ordovician Period. However, the Cambrian and Silurian of Sedgwick and Murchison were found to overlap in places, causing disagreement between the two men. In 1879, Charles Lapworth

resolved the dispute by defining the Ordovician. He recognised that the fossil fauna in the disputed layers was different from both the Cambrian and the Silurian. Lapworth divided up his Ordovician, which is named after the Ordovices tribe who lived in North Wales and mid Wales during Roman times, into the following series: Tremadoc, Arenig, Llanvirn, Caradog and Ashgill, all named after places in Wales or near the border, where rocks of these ages occur. The Llanvirn is subdivided into the Llandeilian and Abereiddian, with the Llandeilian named after the Fforest Fawr Geopark town, Llandeilo and the Abereiddian named after the Pembrokeshire village of Abereiddi. In the UK, these divisions continue to be popularly used, but in some parts of the world, other stages have been used. This led to the standardisation of the Ordovician in 2008 by the International Stratigraphic Committee. The Tremadoc, named after Tremadoc in North Wales, was internationally accepted as the

earliest stage of the Ordovician, but the Llandeilian is not now accepted as an international time period. However, Llandeilo does still possess another claim to geological fame. The very first trilobite described by science was discovered just outside the town; it was collected in 1698 by Rev Edward Lhwyd and he described it as "some kind of flat fish".

A good place to see Ordovician rocks in the geopark is the largest prehistoric hill fort in South Wales, Garn Goch, near the village of Bethlehem. Here, the rocks are coarse sandstones laid down in a shallow sea 405myago, which have since been tightly folded. The geopark has published a geotrail that can give you a guided walk around the geology and archaeology (see box, Published geotrails by the Fforest Fawr Geopark).

Silurian

The rocks of Fforest Fawr Geopark are all sedimentary and pile on top of each other like a layer cake. Overlying the Ordovician rocks are rocks of the Silurian Period. These rocks also occur in the northwest portion of the geopark (see Fig. 1), stretching in a band to the east of the Ordovician rocks near the town of Llandovery to near Llandeilo, with a smaller area occurring just to the north of Brecon. As previously discussed, the Silurian Period was named by Murchison after the Silures tribe, who would have inhabited the Fforest Fawr Geopark during Roman times. Today, the Silurian is divided up into four epochs: the Llandovery, the Wenlock, the Ludlow and the Pridoli. These names are internationally recognised as the official names for rocks of these time periods all around the world. The Llandovery is named after the Fforest Fawr Geopark town, the Ludlow and Wenlock are named after places in the nearby English county of Shropshire; and the Pridoli after a site in the Czech Republic. Each epoch is further subdivided into stages and two of the three Llandovery stages - the Aeronian and Telychian - have their global stratotypes within a few kilometres of the geopark boundary. The Aeronian Age lasted from 440.8 to 438.5mya and is named after Cemcoed-Aeron Farm. The Telychian lasted from 438.5 to 433.4mya and is named after the Pen-lan-Telych Farm. Both farms are in the area surrounding Llandovery.

In Llandovery, Wenlock and Ludlow times, the geopark was still under water, with sediments being deposited in the Iapetus Ocean. In this ocean lived marine creatures, such as brachiopods, which allowed Murchison to define the period and its stages. However, from the mid Silurian onwards, the Iapetus was closing. England and Wales, both part of the ancient micro-continent of Avalonia, were colliding with Scotland, which was part of the ancient continent of Laurentia. This started to form a huge chain of mountains - the Caledonian Mountains - and uplifted the rocks of the geopark area out of the sea. By the latest Silurian (the Pridoli), all the sedimentation taking place in England and Wales was terrestrial; this is why a site in the Czech Republic defines this age, because it was still marine and consequently preserves marine fossils. The rocks deposited in the geopark of Pridoli age are the Raglan Mudstones. They are red in colour and are part of the Old Red Sandstone that continued to be deposited throughout the Devonian, the period that succeeds the Silurian. The global stratotypes of the Telychian and Aeronian are on private land, but a great and accessible place within the geopark to look at Silurian rocks is Sawdde Gorge. This site is an SSSI due to the geology, so no hammering is allowed on the bedrock. Here, the transition from the marine conditions in the Ludlow to the terrestrial conditions in the Pridoli can be seen. The Ludlow sediments from the quarry here have also yielded some of the

earliest known fossils of a primitive fish.

Devonian

The Caledonian Orogeny, the name given to the mountain building event that produced the Caledonian Mountains, lasted into the Middle Devonian. The Caledonian Mountains were a huge chain of mountains that were probably Himalayan in height and stretched from what is now Svalbard down the coasts of East Greenland and western Norway, through the British Isles, on to the Appalachians in North America. Whenever a great chain of mountains is thrust up, it will be eroded down and huge thicknesses of sediment can be deposited in sedimentary basins adjacent to them. The Devonian scene in the Fforest Fawr Geopark would have been something like modern day Pakistan, with a huge mountain chain to the north and an arid plain to the south, over which rivers periodically flooded depositing sediment.

Devonian rocks cover more of the geopark than rocks of any other age and all the high peaks in the geopark - the Black Mountain, Fforest Fawr and the Brecon Beacons (Fig. 2) - are made from Devonian Old Red Sandstone. Many of the rocks are red in colour, as the name would suggest. This is due to haematite that formed in these arid conditions. In other places, the rocks are green and this is the result of a different oxidation state of the iron that may be due to water percolating through the sandstone at a later date. In many



Fig. 2. Pen y Fan, at 886m, is the highest mountain in southern Britain and the Fforest Fawr Geopark.



Fig. 3. Organic remains of early forests in the upper Devonian on the summit of the Black Mountain.



Fig. 4. The unconformity between the lower Devonian Brownstones and the Upper Devonian Plateau Beds on Picws Du on the Black Mountain.



Fig. 5. The author, James Cresswell, pointing out some fossil coral in the Carboniferous Limestone.

places in the geopark, such as on the slopes of Bannau Sir Gaer on the Black Mountain, sedimentary structures (for example, cross bedding) are clearly visible. At a few rare sites, such as Heol Senni Quarry, fossil fish have also been found. The Devonian is also known for the remains of the planet's first forests and, in certain places, such as near the summit of the Black Mountain, black organic material can be found within the sandstone (Fig. 3).

Rocks of the lower Devonian are preserved as the St Maughans, Brownstones and Senni Formations. These are all sandstones and mudstones. However, the middle Devonian is missing so, presumably, there was a period of erosion after they were deposited, removing them before the Upper Devonian Plateau Beds and Grey Grits were laid down. The Plateau Beds are so-called because they cap many of the highest peaks in the geopark. Fig. 4 shows the Plateau Beds lying unconformably on the Brownstones. The best places to see Devonian rocks in the geopark are found in the walks that climb the high mountain peaks. Pen-y-Fan, at 886m, is the highest mountain in southern Britain and the views from the top are magnificent. However, it is also a very popular mountain and, at certain times of the year, can be quiet busy. A wilder and more isolated experience can be had in the west, on the peaks of the Black Mountain.

Carboniferous

As the sedimentary basin continued to fill and subside, the land eventually fell below sea level once again and, in the early Carboniferous, a shallow tropical sea, rather like the modern day Bahamas, formed over the geopark region. This deposited a band of Carboniferous Limestone stretching along the southern margins of the geopark from Carreg Cennen Castle in the west to Merthyr Tydfil in the east (see Fig. 1). In places, these rocks contain fossils of the creatures that lived in the tropical sea, such as corals and crinoids (Fig. 5). A great place to see these fossils is on the geology trail, which leads from Craig-y-nos Country Park to the summit of Cribarth Mountain. This mountain and nearby Penwyllt are also excellent places to see industrial archaeology. Limestone was quarried

here and burnt in lime kilns to provide quick lime for agriculture and the iron industry.

The limestones also host Britain's deepest cave. Ogof Fynnon Ddu is 308m deep and boasts 50km of passageways. This is situated under Penwyllt. However, this is for experienced cavers only, but can be explored by becoming a member of the South Wales Caving Club. A more accessible cave is the nearby Dan-yr-Ogof cave. This cave is part of the National Showcaves Centre of Wales and has extensive walkways, where it is possible to see amazing stalactites and stalagmites. Another notable cave in the geopark is Porth yr Ogof, near to Ystradfellte. It has the largest cave opening in Wales, which is 17m wide and 5m tall.

Overlying the Carboniferous Limestone are three formations of rock that make up the Marros Group. The lower layer of this is the Twrch Sandstone. This is a quartzite and, in places, is 98% silica. This silica was mined at Pontneddfechan near to the current Waterfall Centre, which functions as the geopark's visitor centre, and then crushed to make fire bricks. These were commonly known as Dinas Fire Bricks and were used to line furnaces. They were sold all over the world and, even today in Russia, fire bricks are still known as Dinas Bricks. Overlying the Twrch Sandstone are the Bishopstone Mudstone and Telpyn Sandstone Formations. These alternating layers of mudstone and sandstone form a faulted block over which the many waterfalls of 'Waterfall Country' flow. These waterfalls on the Mellte and Hepste rivers near Pontneddfechan form arguably the finest collection of waterfalls in Britain.

And overlying the Marros Group, but only jutting into the geopark on its extreme southern fringe, are the South Wales Coal Measures. These are responsible for the industrialisation and urbanisation of South Wales, to the south of the Brecon Beacons National Park and Fforest Fawr Geopark. The lower most part of the Coal Measures is the 'Farewell Rock'. This was named first by early iron miners who found no more iron nodules below this rock and the name was later adopted by the coal miners, who also found no coal beneath this layer. The 'Farewell Rock' is beautifully exposed at the

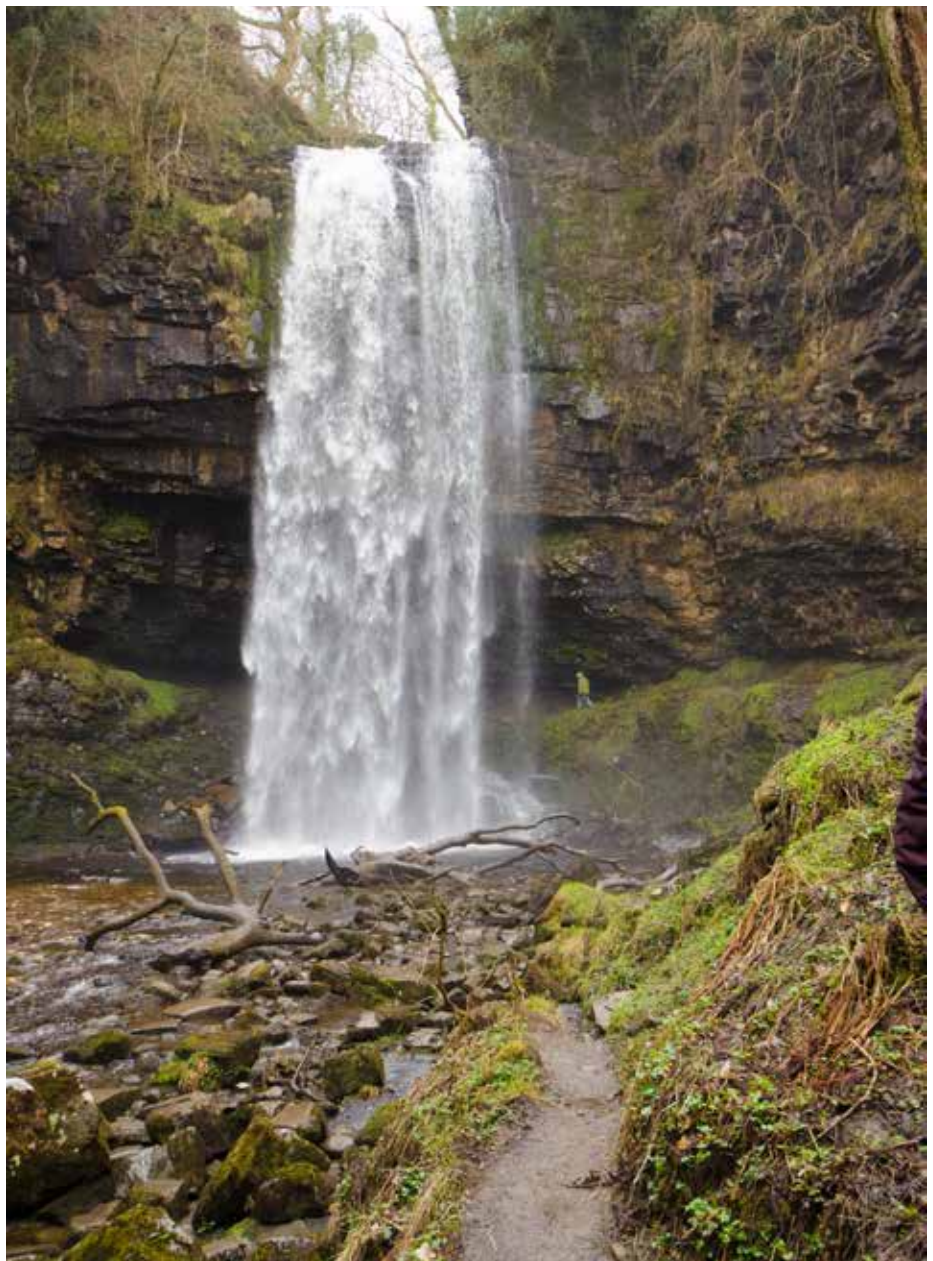


Fig. 6. Henrhyd waterfall, the highest in South Wales, flowing over the 'Farewell Rock'.

Hotspots in the Fforest Fawr Geopark

- 1. Pontneddfechan**, with: the Waterfall Centre, the Farewell Rock, the walk through 'Waterfall Country', the faulted anticline of Bwa Maen, the Neath Disturbance, silica mines, an abandoned gunpowder works and the Cwm Gwrelych Geo Heritage Trail (just over 3km away).
- 2. The Upper Swansea Valley**, with: the geology trail from Craig-y-nos Country Park to the summit of Cribarth, which includes fossils, a Variscan anticline and the Swansea Valley Disturbance; and Penwyllt, with Britain's deepest cave, limestone quarries and abandoned village and train station. It is also possible to visit The National Showcave Centre for Wales, which is not affiliated with the geopark.
- 3. The Black Mountain** near Llandeusan, which includes the geopark's wildest scenery (Fig. 10), best glacial features and excellent outcrops of the Devonian Brownstones, Plateau Beds, Grey Grits and Carboniferous Limestone, as well as featuring in the legend of 'The Lady of the Lake'.
- 4. Carreg Cennen Castle** near Llandeilo (Fig. 9), with the spectacular castle on top of a limestone cliff and the Carreg Cennen Fault, which creates the limestone inlier on which the castle sits.
- 5. Pen y Fan** and the ridge of the Brecon Beacons. This is the classic Brecon Beacons walk, taking in the highest peaks in southern Britain.
- 6. Brynaman**, with the Black Mountain Centre and the nearby Black Mountain quarries (Herbert's Quarry), 'Rocky Ravines', 'From Cwm to Cwm' circular walks and the Henllys Vale Geotrail.



Fig. 7. Bwa Mean, a Variscan fold in the Carboniferous Limestone and the Neath Valley Fault.



Fig. 8. Moraines beneath the cirques of the Black Mountain.



Fig. 9. Carreg Cennen Castle, sitting on top of a Carboniferous Limestone inlier, created by the Carreg Cennen Fault.

Henrhyd Waterfall (Fig. 6), near Coelbren. This is the highest in South Wales and it is possible, with care, to walk behind the waterfall; and it is the Farewell Rock that forms the hard cap over which the water flows. In the 1830s, Sir William Edmond Logan, after whom Canada's highest mountain is named, was mapping the South Wales Coalfield and discovered two fossilised tree trunks in the gorge below the waterfall. These now stand outside Swansea Museum. Another place to see the Farewell Rock is in Pontneddfechan, at the start of the waterfall walk behind the Angel pub. Also near to Pontneddfechan is the Cwm Gwrelych Geo Heritage Trail. This is equipped with audio information points and takes you on a guided walk through coal measures in a previously industrialised valley. Henllys Vale near Brynaman is also another good place to see the coal measures exposed and the geopark has produced a geotrail for this location (see box, Published geotrails by the Fforest Fawr Geopark). However, if you really want to see coal, the best place has to be the National Coal Museum, which is part of the Blaenavon World Heritage Site. This is actually outside the geopark, being near to the eastern boundary of the National Park. Here, it is possible to descend the Big Pit mineshaft and also visit a replica mine. In addition, it is possible to visit the ironworks, where my great-great-grandfather, Edward Pritchard Martin, was the general manager.

Structure

The dominant structural features in the geopark are three parallel faults that run through the park, from the southwest towards the northeast. These are named the Carreg Cennen Fault, the Swansea Valley Disturbance and the Neath Disturbance. These may well represent ancient lines of weakness, from when the landmass of England and Wales was coming together as a series of terranes in the Precambrian. They were active in the Caledonian Orogeny and then again in the later Variscan Orogeny, a mountain building event in the mid to late Carboniferous, caused by Laurussia and Gondwana colliding to form the supercontinent, Pangaea. Even today, as Africa crashes into the

Published geotrails by the Fforest Fawr Geopark

The Fforest Fawr Geopark and the British Geological Survey have produced a series of nine geotrails within the geopark. Each trail has a published leaflet that can guide you on a fascinating walk in the park. These leaflets are available to buy at the Brecon Beacons National Park Visitor Centres. The titles include: Brecon River Usk; Garn Goch - prehistoric fort; Pen-y-crug - a walk from Brecon; Brecon - a walk around the town; Glyn Tarell - glacial features; Henllys Vale - industrial archaeology and coal measures; and Llandoverly - a building stones walk around the town.

The night's sky

In addition to being within the Brecon Beacons National Park, the Fforest Fawr Geopark is situated within the Brecon Beacons International Dark Skies Reserve. This was established in 2013 and is one of only five in the world. It has a light quality good enough to conduct astronomical research.

Europe to form the Alps, it is possible to have small tremors along this fault. In 1999, there was an earthquake measuring 3.5 on the Richter scale, centred on Sennybridge. The Variscan Orogeny also had the effect of folding the pre-existing sediments. The best place to see the structural geology of the geopark is Bwa Maen near Pontneddfechan. Here, the Neath Valley Disturbance can be seen adjacent to a fold in the Carboniferous Limestone, the two structures together form a faulted anticline (see Fig. 7).

Ice age


During the ice ages, most of Wales and northern Britain were covered by ice. These glaciers have sculpted and shaped the beautiful mountains of the geopark, where there are around 30 different cirques cut into the north facing escarpments of the Black Mountain, Fforest Fawr and Brecon Beacons. In these cirques, there are also moraines. Evidence shows that they did not only form at the last glacial maximum about 20,000 years ago, but some of them



Fig. 10. Llyn y Fan Fach seen from the summit of Bennau Sir Gaer, on the Black Mountain.

formed in Younger Dryas stadial, just 12,000 years ago. The best place to see glacial erosion features and moraines is at the base of the Black Mountain ridge, near to Llanddeusant. Here, under the peaks of Bannau Sir Gaer, Picws Du, Fan Brycheiniog and Fan Hir, are classic cirques, but also depositional

features that have been a source of confusion for many geologists. There are moraines that lie in front of headlands rather than cirque mouths (Fig. 8), but they could have been formed as medial moraines, when the cirque glaciers were joining the larger ice sheet that covered all of Wales. Another



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 Mayen, more to follow...



less remote place to look at glacial features is Craig Cerrig-gleisiad, off the main A470, near to Storey Arms and Pen-y-Fan. The Fforest Fawr Geopark produces a geotrail for this area entitled 'Glyn Tarell -

glacial features' (see box, Published geotrails by the Fforest Fawr Geopark).

References

<http://www.fforestfawrgeopark.org.uk/>

Guided geological tours, accommodation and field trips

GeoWorld Travel is based in the Brecon Beacons National Park and can offer guided geological walks in both the geopark and wider National Park area to interested groups. GeoWorld Travel can also offer holiday packages using their four star bed and breakfast (Fig. 11), which offer full board and cordon bleu cuisine, combined with guided geological walks by day and star gazing (weather permitting) in the evening. Additionally, it can offer you electric car hire for a self drive geological tour around the National Park and geopark (Fig. 12).

If you are a school or university, GeoWorld Travel can offer field trips with accommodation food provided by a local outdoor activity centre.

GeoWorld Travel is an accredited Ambassador for the Brecon Beacons National Park, the Fforest Fawr Geopark and the Brecon Beacons International Dark Skies Reserve. For more information, please see. www.geoworldtravel.com.



Fig. 11. Tara B&B, GeoWorld Travel's four star B&B in the Brecon Beacons International Dark Skies Reserve.



Fig. 12. An electric car available for hire on self drive geology tours, parked at Tara B&B.