Fig 13, *Pale crumbly sandstone at the Retreat*

estimate on the board was about 200 million years out!

We had heard and seen about the unique Mosses and Meres of Shropshire on the BBC Countryfile programme which made us determined to visit this unique environment. Although we were too early in the year to see the bogs at their best, the cold weather with snow showers showed how bleak the bog can be. It was, nevertheless a worthwhile visit as we saw many nesting birds and heard cuckoos on many occasions as they looked for suitable bird hosts for their eggs. Perhaps we should return at warmer time of year! Hawkstone Park Follies was a real surprise, in more ways than one, as we did not expect the walk to be such hard, tiring exercise or take as long as it did to walk around. It was, nevertheless, a most interesting and unusual place.

Shropshire County Guide 'Shropshire's Meres and Mosses' by J.A. Bayley (date not known).
'Shropshire Meres and Mosses' 1993 N.Jones. Published by Shropshire Books (out of print)
Further information on the geology of Hawkstone Park can be read in a Field Trip

.Anglesey Field Trip May 2016

Isabel Buckingham

Have you seen the books that clam to train your mind? Ignore them and attempt to understand the geology of the island of Anglesey. The contrasting and contradictory theories will stretch your mind into realms your imagination will struggle to match.
Uniquely the original map and memoir for Anglesey was the self-funded work of one man Greenly, who spent thirty years, assisted by his wife, mapping the island and writing the Memoir which he presented in its entirety to the Geological Survey who published this in 1919. It has very recently been remapped, with much reinterpretation, which is online only. Greenly's mapping is impressive but he was working without any modern methods many of his interpretations have been challenged. This whole island is now a Geopark. Explanation boards are

Fig 1, Basal Carboniferous conglomerate

found.fSome are really very up to date and others use discredited explanations. So accept nothing without careful thought.
In time dates started to emerge and stratigraphical tables were reshuffled. The twin problems are that good exposures are almost all coastal, the interior being covered by glacial deposits, and most junctions are faulted. There is agreement that the area had settled down by the Carboniferous, the Llyn Peninsula should also be considered and that it is very different to Snowdonia.

We looked at certain specific areas and started on the shore at Dulas on the east coast (SH480887) and walked eastwards on a falling tide with Devonian Old Red sandstone to our south on the other side of the bay. We followed Ordovician dark shales dated 444-488mill BP which were sometimes faulted, with noticeable dragging and gradually a steeper dip as we went east. This route is only passable at low water

We met a sudden and marked unconformity, just as we passed the spit, as here the basal bed of the Carboniferous is a conglomerate. There was a sandy matrix, which was supported. It was not well sorted some bits being angular and others well rounded and bits of Monian Ordovician rock were included. There was, on searching, some faint current bedding and channel infill. Opinion had this a mass flow deposit as found in a desert. This was the Basal Bed of the Clwyd Carboniferous Limestone dated at 352 mill B P Could there have been an Equatorial Carboniferous desert? (Fig 1)

Fig 2, *Details of junction with nodules*

We continued, to be faced with a complete change of lithology as we met was a broad dyke of unknown date. The shales were almost vertical at this point and the thick dyke cut across. There was marked blanching of the shales below the dyke. Under this was a layer of soft pale clay with oval nodules one of which seemed to contain Bornite Cu5FeS4 . (Fig 2) As we continued along the shore and saw more intrusions of various sizes and more complex faulting . (Fig 3)It was slow going. We had hoped to get further to the

Fig 3, *Details of Strata*

start of the Carmel Head thrust zone but hunger prevailed and we left the coast by a path to Rhos mynach farm where there was one car, recovered others and drove to Amlwch where the excellent Blueberry Café served up restorative food.

Amlwch and Parys Mountain

If it looks like rain and the wind is cold find something inside, and find out before you go, which is why we had been to Copper Kingdom in Amlwch first, which was a good move. I bought the Parys Mountain trail leaflet there.
Details are at www.copperkingdom.co.uk
The tour can be combined with the Sail Loft museum which deals with the harbour and has a café. (Fig 4) The history of the mining, the complex chemistry of recovering copper from Chalcosine Cu2S, and possibly Bornite Cu5FeS4, production of Ochre and Sulphur and the pollution, including the arsenic fumes, as well as the life of the miners is covered. The ore was dug out, initially open cast, then hit with 4lb hump hammers by “copper ladies” doing 12 hour shifts outside, before being roasted in the first stage. The C19th miners found traces of Bronze Age workings underground. Charcoal dated this to 1900 to 1730BC a narrow time zone explained by the discovery of easier to work ores on Great Orme
The little office for the Anglesey Geopark is also between the two buildings at Amlwch harbour: see

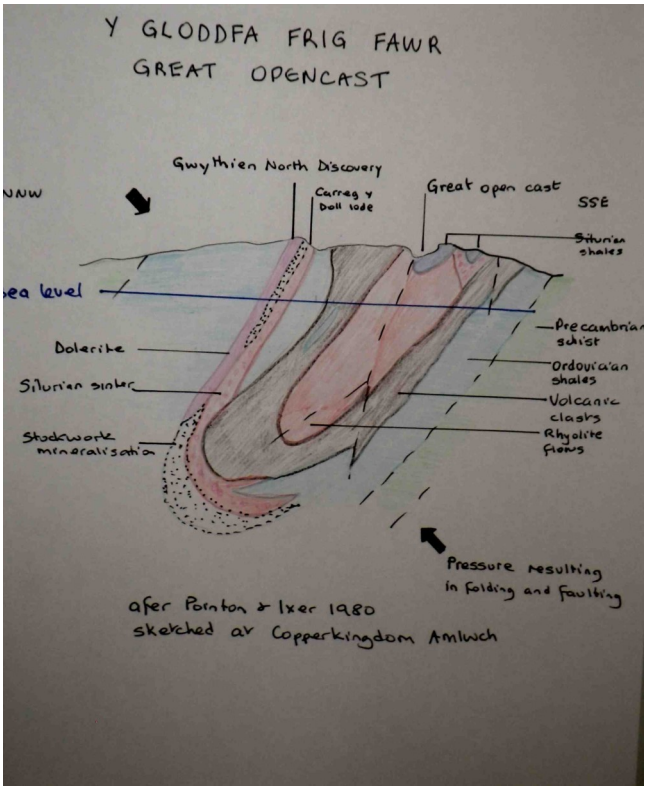

Fig 4, *Parys Mountain sketch*

Fig 5, *industrial wasteland, Parys Mountain*

www.geomon.co.uk.

Parys mountain is now an industrial wasteland where little grows except heather *Calluna vulgaris* and the surface water has ph of<2. (Fig 5) The original mineralisation is thought to be associated with thermal vents in the ocean floor. Silt was laid down with the mineralisation above that. Most of the waste is rhyolite found further out from the core. The whole was strongly folded into a tight slightly overfolded syncline which in turn was faulted at right angles to the fold. These are the only Silurian rocks on Anglesey. Much has been found out from additional boring in the last 20 years and a new shaft has been sunk and awaits an increase in the price of copper as a new substantial ore body has been located to the side and lower than the old workings. The stages of working and processing are well explained. If you think of the worst open cast mines you have seen images of in the third world you can start to imagine this, but add a Welsh hillside climate. The miners had to bid once every two weeks for the next section, guessing how good it would be and the lowest bid obtained the work. This system served to keep them desperately poor. The water table was lowered a few years ago due to the threat of pollution and a dam strengthened.

It is utterly fascinating and I recommend this locality wholeheartedly. The only diagram of the mine geology is from 1980 which is contradicted by a recent geological map.

The Gwna Complex

This was the first melange to be described and Greenly thought that anything that complex had to be Precambrian. However this chaotic and massive underwater slide, formed at an active continental margin seems to be Cambrian-Ediacaran Age which is 508-635 mill BP. The BGS describes a conformable lower margin with the

Fig 6, *Gwna Melange matrix near Lime Kiln*

Fig 7, *clast and matrix*

Church Bay Tuff and the upper limit with the Fydlyn Group. I had previously seen this on the N coast of the Llyn, peninsula but what we accessed from
Llanbadrig church at SH375947 was much clearer. Some clasts are <2km in size and the limestone clast we first saw was a small quarry. I convinced myself I could see stromatolites. A small lime kiln was adjacent. (Fig 6, Fig 7.) The image(s) show the flow and that this is matrix supported, and the orientation of the clasts.
There is excellent parking in the Country Park at Newborough Forest in the SW of

Fig 8, *Pillow Lava, Llanddwyn*

Anglesey, with facilities. The tides were suitable, low and falling as we walked along the wide beach towards Llanddwyn Island but first met a large outcrop. This trip is not safe on a rising tide. This is a pillow lava.

(Fig 8). The outcrop has been rotated, the base being at 11 o'clock. Unusually all sides of the outcrop are visible as the back can be

Fig 9, *Jasper between pillows*

seen. There is Jasper between the pillows. (Fig 9) This is identical to an exposure I've seen near Nefyn on the Llyn Peninsula.
We proceeded on to the island which is part of another Gwna Group Exposure. The Berw Fault runs to the north and the whole island is sheared and faulted, mapped in details by Japanese workers. We observed shattering along a fault (Fig 10) and at another location intrusive veins of Jasper (Fig 11) as well as clear S folds (Fig 12)
Eventually we reached the tip by the

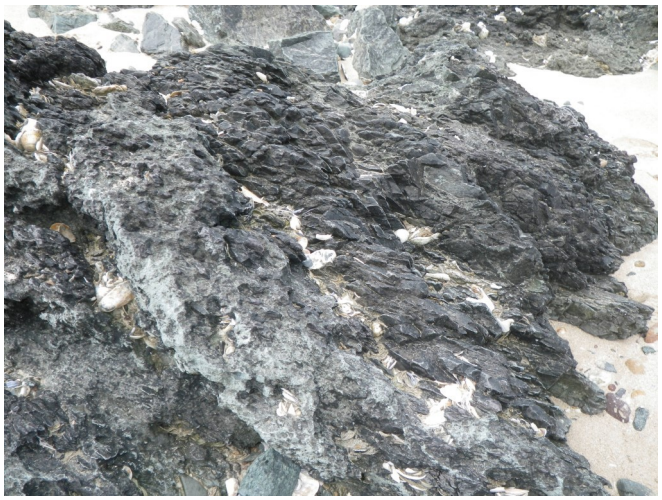

Fig 10, *Shattering of igneous rock along fault plane*

excellent path with crushed shells underfoot. What we saw defied explanation unless you

Fig 11, *Jasper veins in foliated rock*

just accept this as part of the Gwna slide. A calcareous fine grained matrix had basalt splatters, some a few cms across others only visible with a hand lens. The Japanese call this limestone with basalt, the BGs mentions explosive vulcanism and places this in the Church Bay Tuffs. Within 50m were elongated pillow lava, conglomerate and banded Jasper. (Fig 13) Beach shingle

Fig 12, *Close up of S folds*

hid the junctions.
We then travelled north to Holyhead Island and South Stack SH204823 where the RSPB shop has a restaurant and facilities. I had visited previously and marvelled at thousands of razorbill and guillemot, seen some of the 11 pairs of chough and one of the 8 puffin of video cam. There are good steps down to excellent exposures.
The Monian Supergroup is <7km thick and dated 542-635mill BP.
The South Stack formation is the oldest

Fig 13, *Elongated pillows with calcareous mud*

and is probably a nearer shore turbidite deposit with material derived from adjacent land. As it is only lightly metamorphosed the component part are clearly visible as it the considerable

Fig 14, *Folds at South Stack*

folding. (Fig14) Details of the folds show three or four different periods of folding, with clear differences between the competent and less competent beds.
We did not visit the Rhoscolyn Formation.
The Holyhead quartzite is in the middle of the South Stack formation now believed to be Cambrian as a result of a few trace fossils and zircon dating. This is interpreted as a near shore turbidite formation derived from adjacent mature continent. The quartzite forms the highest hill in Anglesey, the “mountain” of Mynydd Twr with the distinctive ice

smoothed summit.
Breakwater Park is a country park at Holyhead on the site of the 11 quarries formed to build the breakwater of the harbour. The Anglesey coast saw many shipwrecks and had little shelter. The Lords of the Admiralty wanted to improve the route to Ireland and the existing pier at Holyhead was exposed to storms and crowded. Work started in 1845, the Act passed in 1847 and the work took until 1873 to complete. The initial plan of two breakwaters was altered as so many ships sheltered there while it was under construction, and one breakwater was elongated and the direction changed. By 1851 1,500 men worked on shifts and 4 wide gauge steam engines were built to carry the stone to the site, as in total 7 million tons of rock were required. Indeed 300,000 tons were needed just for the breaching ground.
Once the breakwater was built quarrying continued as the quartzite was crushed and made into refractory bricks and sent round Britain and elsewhere. When that ended dereliction followed until the decision was made over 25 years ago to turn this into a Country Park. The paths are excellent and this is the easiest way to walk to North Stack or up Holyhead Mountain. There are excellent information boards, and centres, car parking, café and loos. SH228835.

Picture: Quartzite rock fall in quarry and (optional) view over old brick works in another quarry. 23&24.
It must be emphasised that there are

Fig 15, *Infill of Carboniferous Limestone pot-hole*

Fig 16, *Upstanding infill, note shale band behind*

different interpretations of the order of the Monian complex with the Japanese workers Kawai et al dividing the Gwna into two types, dated Type 1 608-600 mill BT and Type 2 540mill BP which is Cambrian. They place New Harbour Group above Rhoscolyn Formation, above Holyhead Formation 501mill BP, and South Stack 522mill BP. This is very similar to the order used by BGS on line but without the dates recently derived from zircon crystals. As the Gwna Group contains clasts of Coedana Granite it must be more recent.
On our last day we went to view another oddity at Red Wharf Bay and parked at SH530811 and headed north east along the shore. This exposed Red Wharf Limestone Formation dated 326-331 mill BP which was a shallow warm water carbonate rich in shells, corals and crinoids. The Brigantian Substage is mapped separately on line and explained as a cyclical shoaling upwards to give a palaeo karst, with solution hollows infilled with fluvial conglomerates, sands and silts. The infill is so hard some are upstanding and none gave a positive

reaction to acid. (Fig 15, 16)
The strange area is fairly confined. An upstanding plug was the basis of a small cave and showed that material was more resistant to marine erosion than the limestone. The distribution of the karst features suggested an uneven polygon in places. Yet again it was a struggle to envisage the sequence of events.
Lastly and for convenience as it is near the exit to Anglesey, was a visit to the site under the Marquis of Anglesey Column. Access is from the A5 to a carpark and an explanation board that was not as up to date as others we had seen. The quarry is the where the Blue Schist is found. This is part of the Menai Strait fault system and lies between the Menai Fault and the Berw Fault. There seems to have been low temperature but high pressure metamorphism. Indeed bits of unaltered basalt, an ocean floor sediment from about 585mill B were visible in the schist. The explanation is that this was not at depth for long enough to be fully metamorphosed into schist but was scraped off and squeezed upwards as the remainder was subducted about 550mill BP. This may have all happened in a deep ocean trench.
My default dates are from the BGS web site, but narrower specific ones are used when there is recent zircon crystal U-Pb dates available. The Japanese work suggests a date for the New Harbour Group of 472 mill BP +/-30 which is Lower Ordovician, and South Stack 501mill BP +/-10 which is mid Cambrian. The main theories are contradictory and in a state of constant modification so I will leave that to experts.

My thanks go to Dave Green who ably and enthusiastically guided us around and made us think hard. The errors in the account are all mine. We were blessed with idea sunny weather, and the delights of the wild flowers along the coastal paths. The geopark status is well deserved.

German Geoparks

Isabel Buckingham

When visiting Germany for work, holiday or just passing through it is worth checking the Geoparks if you have any time in hand at all. As my husband has a small German registered plane we are asked to some out of the way locations and can end up unexpectedly landing somewhere due to bad weather.
The starting point is www.nationaler-geopark.de which offers translation and has interactive maps. All national Geoparks are listed, not all yet with UNESCO status, as well as those being

Map 1, *German Geoparks*

worked on at present. Some have twin designation as Nature Parks for recrea-