Earth Matters

The Newsletter of the Geology Section

of the Woolhope Naturalists' Field Club

No. 7 December 2010

The Geology Section is an Affiliate Member of the Geologists' Association.
The Woolhope Naturalists' Field Club is a Registered Charity, No. 521000

Contents

Message from the Chairman

ONCE again, I can say that we've had a good year and this despite some very wintery weather that set in just when some of us were beginning fieldwork on an EHT programme. However, I want to digress from the Herefordshire scene and look further afield.

Last year I recalled Iain Stewart's remarks at the GA Dinner in 2008. Iain gave an up beat and optimistic speech but things seem not to be working out quite so well as he anticipated. I refer to the current economic downturn; to the effects this is already having on geology and geoconservation; and the likely outcome. We in the WGS may not appear to be greatly affected, possibly as individuals, but more certainly as a group of like-minded persons with a common interest. Unfortunately, this cannot be said for professional geologists. Recent years have seen a steady decline in the universities, with geology departments either closing or the geological content subsumed into other departments. In fact, this very theme arose repeatedly during our recent excursion to Aberystwyth where exactly this had occurred.

Earlier this year Julie Harrald, EHT Secretary, emailed her committee about cuts in Geological Conservation Review staffing at the Joint Nature Conservancy Committee; two of the three staff members had already been redeployed. We were asked to respond, presenting a reasoned case for opposing the cuts, rather than just expressions of dismay and general disapproval.

I promptly composed a letter on behalf of the WGS and, yes, I did express my genuine dismay, but I was also careful to formulate a number of detailed questions. I have just received a polite but bland reply, full of 'quango-committee-speak' that doesn't address the specific questions I had raised. Instead, I now find that this letter is just a circular, identical to one that Sue Hay also received. Well, I'm sorry folks, but in view of the more recent developments, I fear it can only get worse!

Gerry Calderbank, *Chairman*

Geology Section Programme for Early 2011

LECTURES and the Annual General Meeting are held in the Woolhope Room, Hereford Library, Broad Street commencing at 6:00pm unless otherwise stated.

Friday January 21st. 'A geological tour of North East Greenland'
Lecture by David Rex.

Friday Febuary 25th. Section AGM followed by the Section Dinner at Ascari. Booking forms for the dinner will be sent out electronically in January.

Friday March 18th. 'The Magallanes Basin in Southern Patagonia'

Lecture by Dr Bill Fitches
This talk will include Mesozoic-Tertiary turbidites and channel deposits (much like Aberystwyth and Rhayader), oil and gas generation, huge mountains of granite and stunning glaciers.

Sunday April 3rd. Visit to Gore Quarry and Stanner Rocks .
Led by Dr Geoff Steel.
Both sites expose Precambrian rocks within the southern part of the Church Stretton Fault Zone.
Meet at 10am at the quarry entrance which is located on a small side road just off A44 about 1km north of Stanner Rocks (SO 259 592). Hard hats and fluorescent jackets are needed for the quarry. Please bring a packed lunch.
Further information for all events unless otherwise stated from: Sue Hay, 01432-357138 or e-mail svh.gabbros@btinternet.com. Please note until the Woolhope web site upgrade is completed the information shown there may not be accurate.

A further geological event: Dr Paul Olver is leading a Geologists' Association study trip to France 7th-19th April 2011. This will be a circular geological tour by coach introducing a wide variety of sedimentary, igneous and metamorphic rocks. If interested please contact Paul directly (paulolver@hotmail.com or 01432-761693).

Editor's note

WELCOME to the seventh issue of Earth Matters. This year, two of the articles deal with local research activities. This is an aspect which I am keen to encourage, perhaps as preliminaries to full publication of research results in the Transactions. Indeed, Professor Bryant is in the process of writing such a paper and his article in this issue is an early and abbreviated account of his work in the Black Mountains. The work at Martley Pit, described by Paul Olver, is less advanced but is intended to follow the same publication route.

Elsewhere, we have a geological holiday report, a valuable write-up by Richard Edwards of a part of his lecture on metamorphism and the usual accounts of WGS meetings.

I wish to offer my thanks to all the contributors for their timely submission of what I perceive to be high quality articles.

John Payne, *Editor*

Subscriptions

THE ANNUAL SUBSCRIPTION to the Geology Section is currently £7.00. This is due on 1st January (as for all other WNFC subscriptions). Please pay this directly, and on time, to the Section Treasurer, Beryl Harding, 'Bramley', Lugwardine, Hereford HR1 4AE. **Do not** send it to the WNFC Secretary with your WNFC subscription. Cheques should be made payable to 'Geology Section / WNFC'. Members are encouraged alternatively to pay by Standing Order; forms are available from Beryl.

Annual General Meeting

MEMBERS are asked to accept this as notification of the Geology Section AGM to be held on **Friday 25th February 2011** starting at 6:00pm in the Woolhope Room. After the AGM we will retire for dinner to Ascari's restaurant. Booking forms for the dinner will be e-mailed to members in January.

The officials and committee for the coming year will be elected. All of the present committee members (see the back page of this issue) will stand for re-election. There is a vacancy on the committee for an additional member. Section members are invited to submit nominations for election to this post. Nominations, with the names of the proposer and a seconder, must be received by the Section Secretary in writing (letter or e-mail) before 25th January 2011.

On-Line Geology Maps from BGS

MEMBERS may not be aware that the chief geology maps of the British Geological Survey are now available on-line. (http://maps.bgs.ac.uk/geologyviewer_google/googleviewer.html) Both the 1:625000 and 1:50000 scale maps are available. They may be viewed, saved and printed superimposed, if desired, upon aerial photographs from Google Earth. This allows easy location of geological features on the ground. Both superficial and bedrock geology are shown but not faults or made ground. Nor is offshore geology included.

Positioning the computer cursor at any point on the map reveals a text box showing the names of the bedrock and superficial deposit at that place. For the 1:50000 maps, a stratigraphic key may be generated in an additional panel, linking the map colours with stratigraphic names. Unfortunately for those wishing to print the maps for field use, this key displays only about four stratigraphic units at a time.

As you might expect, BGS do not allow each displayed map to cover a large area. At 1:50000, the frame covers about 10 x 7 km^2, big enough to cover many field excursions.

A Weekend in West Wales - September 2010

Gerry Calderbank

BY EARLY EVENING on Friday, 3rd September, a select band of members had gathered at one of the halls of residence on the Penglais Hill campus of Aberystwyth University; this was prior to meeting our guide for the weekend who joined us for supper. We immediately warmed to the presence of Bill Fitches, who had kindly agreed to give up his weekend for our benefit by conducting us on a tour of the local geology - and this commenced with an introductory talk immediately after supper.

THE BRIEFING

Bill explained that the weekend would have two themes, with the Saturday taken up by an exploration of various exposures revealing basinal mud and turbidite shelf deposits of Silurian age, and that these represent the deep-water end of the Welsh Basin, rather than the near-shore limestones and associated rocks with which we are probably more familiar locally. These deep-water deposits had accumulated over a period of about 20 million years from the late Ordovician to early Silurian times. They conceal the underlying Precambrian basement, itself covered by older Lower Palaeozoic rocks, the nature of which is therefore uncertain, but may well include mid-Ordovician volcanics. Whereas our local rocks were deposited at the shallow margin of this basin and are highly fossiliferous in consequence, the deep-water deposits supported fewer life forms; this deficiency is attributable to both the depth and the structural conditions experienced in their deposition. The turbidites contain relatively few fossils, whereas the grey shales can feature graptolites. Graptolites are an extinct group of free-floating animals, sometimes found in abundance, and always important (where present) in the identification of the precise stratigraphical horizons. In fact, their extinction marks the end of the Lower Palaeozoic. Sunday was to be spent in the Central Wales Orefield.

Gerry explores the Aberystwyth Grits

The nature of turbidites, their origins and turbulent formation was explained at some length; this exposition therefore required further reference to submarine canyons and other erosional/depositional features associated with such continental shelf deposits. In brief, the turbidites commenced as shallow water accumulations of unstable sediments that periodically avalanched to the deeper floor of the basin and, in doing so, they carved gullies and canyons in the existing sediments. It will be apparent that, in order to effect such submarine erosion, the energy levels were extremely high, with the turbidity currents capable of speeds up to 50-80km/hr sustained over many tens of kilometers; in effect, they may be regarded as dense, mobile, homogenous bodies of 'slurry'. It is thought that the avalanching was probably triggered by tremors and more severe earthquake activity, characteristic of the period - or just, possibly, by severe storms.

Other contemporaneous rock types associated with these beds are, respectively, conglomerates and hemipelagites, with the latter tending to be fossiliferous since, unlike the turbidites, they were relatively undisturbed in transit so that any shelly fossil fragments were less prone to damage. The conglomerates represent pebbly in-filling of the turbidity channels, whereas hemipelagites include the dark grey /black organic and sulphide-rich graptolitic mudstones, laid down during periods when the coarse sediment supply diminished. Having described the nature of turbidites and their dynamics, Bill then outlined some of the features associated with them in order that we should know what to expect next morning. There followed an account covering various further technical terms, including trace fossils, folding and faulting (all familiar) but with some novelties such as flute casts, groove casts and cone-in-cone concretions. Flute casts are infilled V-shaped hollows caused by vortices in the current. Groove casts are scarring of the sediment by objects such as pebbles and shells as they are dragged across the existing sediments. Cone-in-cone concretions are chemical concretions, forming not long after the sediment was deposited. This completed our briefing and, with our thirst for knowledge suitably satisfied, we all adjourned to the bar of the Staff House in order to quench our more corporeal thirsts before retiring.

Bill Fitches points out some gutter casts.

SATURDAY

Location 1: The North Shore - Aberystwyth Grit Formation; Llandovery Series (SN 583 827)

Next morning Bill joined us immediately after breakfast and we drove to the promenade. Our first pause was at the mouth of a shallow wave-cut cove where, armed with our newly acquired knowledge, we were able to inspect the features described. There was faulting and folding to be seen and, because of the nature of the rock, we were able to observe the underside of some of the strata which displayed the somewhat unusual features referred to in our briefing. Their exposure occurs because the turbidites suffer differential erosion in such a way that the upper layers of each stratum, being relatively softer than those below, erode faster than the gritty base of the next stratum above, thus exposing its underside. It also means that the strata become very unstable since the weight of unsupported rock soon leads to collapse. Rock falls are therefore common and, given the instability, no great overhang can develop so substantial sea-caves rarely develop unless faulting plays a part.

Inspecting the turbidites.

Although commonplace, the trace fossils we saw are virtually the only indication of animal life in these particular rocks. It was explained that the orientation of the flute casts we observed is an indication of the directional flow of the turbidity current that caused them, since their pointed ends always face towards the flow's origin. Having referred to their differential erosion, the composition of the individual layers of sediment possibly needs some further comment. In the process of descent, the turbidity current first relinquished its coarser, heavier burden, with the remaining load gradually tailing off to finer and finer deposits as it gradually slowed to a halt; unfortunately, the horizontal scale is such that this would scarcely be observable in plan view. This is not so in section however, because each band of lithified sediment displays precisely such grading from coarse basal components (sandstone or 'grit') through siltstone to mudstone - a reflection of the waning current velocity contained within just a few centimeters thickness of rock! Perhaps less intuitive is the fact that some of the intermediate bands within any such episode (grit to mudstone) may sometimes contain laminae that have been folded into convolutions (obviously, before lithification) and that these are then truncated by the succeeding laminae above them. The sight of a pair of dolphins was something of a distraction!

We were next faced by a massive stone-built groyne surmounted by a rusty iron ladder allowing access to the adjacent, somewhat larger cove. There was little difference here, except that the north flank of the cove was pierced by a blow-hole. This gives access towards Cormorant Rock, the remains of a sea stack, and each of these probably originates from the exploitation of a fault-weakened zone by wave action. We then returned to the promenade and, having regained the storm beach, there was a pause to examine the pebbles whilst Bill explained something of their diversity and provenance. In particular, our attention was drawn to the distinctive, ovoid specimens of the far-travelled Ailsa Craig Microgranite. This Tertiary granite originates solely from the Scottish island of that name and its redistribution therefore provides a unique marker for the direction and route of the Pleistocene glaciation(s).

Location 2: Borth Beach - Borth Mudstone Formation; Llandovery Series (SN 607 888)

We next drove to the car park at the south end of Borth beach. A short stroll brought us to the cliff face where the exposure is seen to consist of the Borth Mudstone turbidites, described as follows: "The formation comprises medium to dark grey turbiditic mudstones with paler bands, 1-2cm thick, consisting of parallel-laminated or cross-laminated silt-stone present at 10-30cm intervals. These sediments were deposited distal to both the easterly-derived Devil's Bridge Formation and to a part of the Aberystwyth Grits. A traverse across the 300m distance reveals the existence of several small anticlines and synclines. The vertical or overturned limbs strike at N010º and dip at moderate angles to the south-east. Cleavage is developed in the vertical limbs but runs parallel to the bedding in the more gently inclined ones. Gullies on the foreshore mark the positions of faults and these are associated with prominent quartz veining."

A picnic lunch was taken on the rocky beach as we were entertained by another couple of dolphins close inshore.

Location 3: Allt-Wen - Aberystwyth Grit Formation; Llandovery Series (SN 576 795)

Our next visit entailed a rain soaked tramp to the shoreline

Soft sediment structures at Carn Owen

bounded by low cliffs just south of the Ystwyth storm beach. Whilst otherwise similar to the earlier (North Shore) Aberystwyth Grit exposures, the beds here are noteworthy for their complex folding and detachment (‘décollement’) structures, some of which can be difficult to detect. Small thrusts commonly display bedding-parallel veins (up to 5mm thick) composed mainly of quartz and ferroan dolomite. Such veins were formed by over-pressurised pore fluids and acted as planes of movement, with their striated surfaces indicating a WNW to ESE axial displacement. Whereas the subject is somewhat complicated (except for the likes of Bill Fitches!), you may have gathered that some distortion either occurs in transit or is penecontemporaneous. The large-scale (regional) folding and faulting is much later, of course.

Back on campus, a convivial evening meal was shared with Bill in the Staff House; the food was beautifully prepared and thoroughly delicious - a delightful end to a most enjoyable day!

SUNDAY

Location 4: Carn Owen - Drosgol Formation (Pencerrigtewion Member) (SN 732 880)

Fossil hunting at Carn Owen

Sunday's itinerary was arranged so that all drivers were to rendezvous at the Forestry Commission's red kite feeding station, Nant-yr-Arian. Some vehicles were parked here whilst we drove to Carn Owen, which is remotely situated and reached by a mountain road from Ponterwyd via the upper Rheidol valley and Nant-y-Moch Reservoir.

This RIGS is a disused quarry, situated in the core of an Ordovician inlier to the west of the Plynlymon massif, elevation 482m. The formation is a spectacularly denuded anticline, presenting one of the best (accessible) examples of large-scale soft sediment deformation in Wales, and it is therefore of particular importance to the study of such phenomena. The most striking feature is the large masses of light-coloured sandstones enclosed by grey mudstones. However, the cause is debatable, there being two alternative theories. One possible explanation invokes a large mass of sand, transported from the northeast along a submarine channel and then deposited onto the floor of a deep-water basin, but with the admixture of 'levee' slumpage incorporated within the sand body. Alternatively, it could be a case of de-watering, with the mass of sand deposited on still-saturated sediments, sinkage through this, and the more buoyant wet mud then squirting up through this, rather like quicksand. Whereas the cause may be debatable, it is certain that the event occurred before the sediments were fully consolidated.

Location 5: Llywernog Silver-Lead Mine (SN 732 809)

A quick visit: although we were able to wander around the surface displays, there was no time to go underground but some of us will be sure to spend half a day here in the future. Lead and silver frequently occur in the same ore, when the galena may contain from 5-8oz per ton but, as with all such mining, viability depends upon the world commodity markets.

Location 6: Disused Lead Mine - near Dyffryn Castell (SN 774 812)

A short stroll up the rock strewn track, then contortions with a barbed wire fence gave access to a deep hole in the ground, typical of many such disused mines. Unless fenced off, they can be very hazardous and, as a rambler, I have sometimes seen dire warnings posted to this effect! Scattered around this site there were masses of waste material, some fragments of which were coated with quartz crystals; in this context, such quartz is referred to as a 'gangue' mineral - as opposed to the ore minerals removed by mining. Quartz is by far the commonest gangue mineral in the Central Wales Ore Field, although calcite and sometimes ferroan dolomite can also be found.

'Mineralisation' is a word with several meanings but, in mining geology, it usually refers the process by which both ore and gangue minerals are progressively introduced into pre-existing rocks, either by gradual blanket replacement of existing minerals or by more 'targeted' and localised emplacement in a rock fissure. 'Lode' is the old Cornish term for such a mineralized fracture, but the word 'vein' has more modern currency and is generally preferred nowadays. The actual process occurs because the Earth's

Waterwheel at the Llywernog silver-lead mine

Continued on page 11

Meeting Reports, 2009-10

by Geoff Steel and John Payne

Friday 4th December 2009 : Members' Evening

Sue Hay described her recent trip to Dillenburg in Germany. It is twinned with Hereford but Sue found that they have little in common. She showed slides of igneous outcrops in the nearby hills, including vesicular basalt and pillow lavas, and she passed around some samples.

Richard Edwards described a series of Triassic exposures. He started with fluvial sediments on the Wirral, which were deposited by a large river flowing northwards from France during lower Triassic times. From Chester, he showed a fluvial channel which can be seen from three sides giving a full three-dimensional exposure. Finally he showed the Arden Sandstone at Sudeley Farm near Upton. It was formed in an estuarine environment in the mid-Triassic.

Alan Stone showed photos from his holiday at Sierra Espuna in Spain. It is a dry, arid area of sandstones and limestones of Permian to Tertiary age. Most of the sediments are soft and easily eroded into steep gullies. He collected some beautiful gypsum crystals. Robert Williams showed samples from Bromfield gravel pit which was part of a glacial lake. They were transported by glaciers from Wales and the Longmynd. Moira Jenkins brought a colonial coral from the Crease Limestone on the Little Doward. It was found during an archaeological excavation which also revealed a limestone pavement below the Iron Age hill fort. Geoff Steel showed microtektites from Wickwar, originating from the Manicouagan impact crater in Canada.

Friday 26th February 2010 : AGM and Dinner

The Chairman, Gerry Calderbank, gave his review of the year in the form of personal 'highlights'. He thanked the Committee and the Publications Working Party for their support.

There have been good sales for the DVD ‘Picnic in Siluria’, including sales to local schools. Some feedback is that it would be helpful to include additional background material with the disc, and this is indeed planned. A vote of thanks was given to Lawrence Banks for his financial support both for the DVD and for the planned book on Herefordshire geology. The book's title is uncertain and needs to avoid confusion with Hertfordshire (for which a similar book has just appeared). Publication is expected in spring 2011. The Secretary, Paul Olver, has recently been elected to the National Council for the Geologists' Association. He described their aim to be less focussed on London, which should be an advantage to those of us further afield. The existing committee was re-elected with the post of Earth Matters editor (John Payne) being approved as an addition.

By popular request, the annual dinner was again held in the upstairs restaurant at Ascari. Fine food, good service and a relaxed atmosphere completed an enjoyable evening.

Members study exhibits at the Members' Evening

Friday 26th March 2010 : Changing rocks, changing ideas - 200 years of Metamorphism

Richard Edwards presented this talk as a historical narrative. Parts of the talk are presented in detail elsewhere in this issue. He investigated the life and times of the people involved and showed how acceptance of ideas can be influenced as much by personality as by scientific evidence.

Serious geological debate began in the 1770s with the opposing theories of 'Neptunists' and 'Plutonists'. Leading the former was Werner in Germany who believed that granite was the oldest rock, deposited from solution, with inclined strata growing around it like crystals. His ideas were wrong but he was a persuasive speaker; people would travel great distances across Europe to attend his lectures. By contrast, James Hutton, working in Scotland, was more observant and interpreted geology as a dynamic process driven by conversion of the Earth's internal heat into mechanical energy.

It took the work of Charles Lyell ("The present is the key to the past.") to sort out a rational framework. He developed the idea of metamorphism and was very influential to Charles Darwin who recognised the sequence: slate - phyllite - schist - gneiss. The change is a recrystallisation. George Barrow continued the same idea with his identification of metamorphic isograds. However, his paper was ignored for 30 years.

Dick explains the structure of Black Daren.

Finally, Richard described the advance in plate tectonics, which took place while he himself was a student. Thought to be rubbish in 1962 the theory became well established by 1965 - an amazing change of ideas in such a short time!

Saturday 24th April 2010 : The Darens and Cats Back

This trip was to the Herefordshire part of the Black Mountains. Nineteen members attended on a sunny day. It was led by Dick Bryant. Duncan Hawley also was present and made many very instructive inputs. In the morning, the geomorphology and geology of the adjacent

Duncan Hawley and John Stocks at the Cat's Back

crags of Black Daren and Red Daren were inspected. Dick talked about the particularly intriguing geomorphology of Black Daren. The detachment of a section of the cliff may be the result of either slumping of that part of the cliff or, less likely, the water erosion of a channel. Likewise, the detailed nature and origin of the several ridges of slumped material is unknown as is even their age. There was much discussion about this. Duncan described the geology and showed various trace fossils including a probable small Beaconites.

In the afternoon the party visited the Cats Back a few kilometres to the north. Here the stratigraphy is very accessible for close inspection. Duncan spoke about the palaeogeography and the environment in which the strata were formed. We saw the details of the sandstone layers and intervening calcretes. Fine examples of soft sediment deformation were found at one location. Duncan also showed us trace fossils in the sandstones; these have only very recently been identified as plant root traces.

The group reassembles after lunch on one of the debris ridges at Cwm Cerrig Gleisiad. The remains of the landslip are behind to the right.

Sunday 23rd May 2010 : Cwm Cerrig Gleisiad

Duncan Hawley joined the group for the second time in a month, this time as leader. Cwm Cerrig Gleisiad lies a couple of miles west of Pen y Fan in the Brecon Beacons. Although it is generally agreed to be an ice-sculptured site, it contains several features which differ from those of other cwms in the area; it is not a classic 'arm chair' form, it sits about 100m lower than other cwms (raising questions about the supply of snow to its glacier) and it

Duncan stands on a collapsing block at the top of the landslip. Behind are the southern cliffs of the Cwm and, to the left, the peaks of the Brecon Beacons.

contains a particularly complex set of debris ridges in its floor. Duncan led the party in a consideration of the various possibilities for the origins of the landforms, eventu-

ally arriving at the latest and most satisfactory theory, a major landslip in the western wall. In the process of this, the group traversed the cwm floor a couple of times and then climbed to the top of the cwm. The weather was hot but the views in the clear air were superb, especially of the major peaks to the east. The fourteen participants (and a dog) enjoyed it immensely.

Saturday 19th June 2010 : Aust Cliff

This expedition of eight members was ably led by Simon Carpenter, a local fossils expert. We met on the coast road at Old Passage where Simon started the trip by showing us examples of fossils which he had found at Aust Cliff. These included particularly fish teeth and some large vertebrate bones. A short walk led us to the spectacular, near-vertical exposure on the shore of the Severn Estuary. Here Simon described the stratigraphy. The rocks range from Late Triassic red Mercia Mudstone to Early Jurassic light grey Cotham Marble. The sequence includes the famous Bone Bed, the source of many fossils, especially

A part of Manor Farm Quarry.

fish teeth and coprolites. The lower part of the red mudstone includes some very marked strata of gypsum with vertical gypsum bands between them. The origin of the vertical bands is still the subject of debate. The whole exposure rests unconformably on a base of Carboniferous Limestone. The party spent much time here searching for Bone Bed fragments and other interesting features in the rocks fallen from the cliff top, with some success.

After lunch in Aust village, the group visited the nearby Manor Farm Quarry. This is a RIGS which has good and accessible outcrops of the inaccessible upper strata at Aust Cliff. The quarry was successfully searched for fish fossils and some examples of the stromatolitic Cotham Marble were found.

Saturday 7th August 2010 : Kington and Hergest Ridge

On a day which started showery but gradually improved, Moira Jenkins led a party around sites in Kington and then over Hergest Ridge. Thirteen members from WGS and the Mid-Wales Geological Society took part.

Searching the beach at Aust Cliff for fossils. The gypsum features are in the cliff behind.

In town, a wall of Downton Castle Sandstone showed several interesting cross-bedding features. Moira led us to an old quarry in Ludlow rocks showing a dip direction opposed to that of the region, and then to a bank on the by-pass where Silurian fossils are abundant. A half hour was spent collecting fossils here before we went a little way up Bradnor Hill to see good examples of hummocky ground (a moraine) and a kettle hole.

The group then climbed the 250m to the top of Hergest Ridge. There we enjoyed the splendid views in all directions and noted many showers occurring in Herefordshire. Moira explained the local topography, which is largely a consequence of the ancient Church Stretton Fault System. She led us to the Whet Stone, a large glacial erratic of the distinctive gabbro from nearby Hanter Hill. We studied the stone mounds around the crest of the hill. Some of these low mounds are of prehistoric origin and others are the result of wartime clearance for agriculture.

The walk back to Kington was by way of a glacial meltwater channel cut into the south-east side of the ridge. This led to Castle Twts, a motte and bailey built on a glacial moraine crossing the valley of the River Arrow. Passing another kettle hole, we arrived back at Kington.

The Whet Stone erratic on Hergest Ridge.

THE BURREN

'A country where there is not enough water to drown a man, wood enough to hang one, nor earth to bury him'. (Edmund Ludlow, commander of the English army in Ireland 1651-2)

Charles and Jean Hopkinson

THE BURREN in County Clare, Ireland, is known as a paradise for botanists and for its interest to geologists. Covering some 215 square miles, it lies to the south of Galway Bay and is one of finest glaciokarst landscapes in the world. Here we spent a week in May 2010 pursuing our geological and botanical interests.

The dominant rock in the Burren is Carboniferous limestone which in places is capped by impermeable Clare Shales also of the Carboniferous. The limestone is underpinned by the Old Red Sandstone, and below this, at least in the north and west of the Burren, are Galway Granites of c.400Ma. Tectonic activity has folded and tilted the limestone beds of the south-eastern Burren forming, for example, the syncline on Mullagh More. The limestone beds, particularly the higher ones, are fossiliferous with corals, brachiopods, etc.

The greater part of the region was subjected to several glaciations. These eroded most of the shales and loose rock, and exposed the limestone pavements as well as depositing boulder clay in the valleys and as moraines and drumlins. The last glaciation, ending about 11000 years ago, was from the north-east as is evident from both occasional erratics of granite and other rocks from the north, as well as glacial striations. The latter have survived erosion only where covered by other material and, as we were warned, should not be confused with badgers sharpening their claws!

A doline bisected by a Famine Relief Road constructed in the 1840s to relieve poverty.

In the Burren can be found all the features of karstification - clints, grykes, kamenitzas, rinnenkarren, rillenkarren, etc. (terminology with which we were largely unacquainted). Drainage is subterranean; the few surface streams are found only on the impermeable shales or where they flow over boulder clay. As well as the region's conventional lakes there are seasonal lakes known as turloughs. These are mostly fed by groundwater flowing through swallow holes at the bottom of depressions caused by subterranean structural collapses - dolines or sink holes - into a network of underground waterways. In dry weather turloughs may disappear, but when the water cannot drain fast enough from them below ground they may temporarily cover many acres.

The syncline on Mullach More from the west, with a part-turlough, part-lake.

Whilst the Burren may lack the geological variety of other regions, it makes up for this in the intensity of its particular geology. And should one want a break from glaciokarstification, take a day off in the mountains of Connemara with their dramatic scenery and totally different geology - but that is another story.

MARTLEY PIT

Paul Olver

THE BGS DROITWICH SHEET (No. 182) has always shown an intriguing small outcrop of the Precambrian rocks about a half mile west-south-west of Martley village (SO 7450 5956). Closer inspection of this area by the author and other members of the Geology Section in June 2005 revealed a small coppice of young fir trees lining the area of the outcrop. Nearby fields to the north, however, yielded abundant angular fragments of diorite, pegmatite and yellowish quartzite. Augering close to the northern edge of the coppice revealed *in situ* igneous rocks beneath a thin layer of soil.

Discussion with the landowner at that time, Mr. Taylor, allowed the group to piece together the more recent history of the former Martley Gravel Pit. Although an active aggregate site from early Victorian times when the Precambrian exposure was first recorded by Murchison (1839), it seems that by the mid-20th century little extraction was taking place. A report by Barclay and Rathbone (1990) for BGS reveals that only a small exposure of diorite and green micaceous schist could be seen on the west while some white quartzite rock was still visible on the eastern side. The remainder of the pit at this time was a repository for domestic refuse. The mid-1990s saw the final infilling of the pit and the planting of the fir trees seen today.

Unfortunately, all geological investigations at Martley were brought to a sudden end with the death of the landowner. Discussions were re-opened with his widow, Helen, in early 2010 and it was agreed that a full site visit would take place on 3rd February 2010.

It was on this morning that the decision was made to dig trenches across the strike of the main rock units to the north of the pit and at right angles into the former gravel pit but to the west of the small coppice. A JCB was available for the job late in the morning and, by lunch time, the full geological structure had been revealed, much of it for the first time. Much sooner than expected, the Woolhope Club's Geology Section had a new and important exposure to fully record and analyse.

The site is bounded on the east by the East Malvern Fault which brings downthrown Bromsgrove Sandstone (Triassic) against almost flat-lying Halesowen Beds (Upper Carboniferous). At the north-western end of the longer NW-SE trench, the same Halesowen Beds rest unconformably on the Siluro-Devonian Raglan Mudstone Formation.

The middle of the NW-SE trench and the shorter side trench reveal a highly tectonised sequence of Precambrian and Cambrian(?) rocks.

The Precambrian Malverns Complex consists of a sequence of mafic igneous rocks together with fresh, pink and green mottled diorites showing narrow areas of high shearing and shattering. In the side trench, the Precambrian rock is very weathered except for a highly acid pegmatite horizon which has resisted the shearing processes.

Members inspect the new trench at Martley Pit.

Within this Precambrian are tectonic slices of yellowish quartzite, similar to that of the Cambrian Malvern Quartzite, but as yet undated by microfossils. A Cambrian age has been postulated but a later date, as with the Ordovician Lickey Quartzite, can not be completely ruled out.

The quartzite is seen to be thrust over the Carboniferous Halesowen Beds in the NW of the long trench along a very low angle thrust. To the SE within the same trench, the quartzite is faulted against the Malverns Complex in a narrow, steeply dipping fault slice. This is immediately followed to the SE by a second parallel fault slice of tectonised yellow and grey quartzites. Finally, further to the SE, a steep fault separates this final fault slice from further Malvernian mafic igneous rocks.

This fault zone supports Groom's analysis (1900) that the Precambrian has been tectonically interleaved with the

Lens of orange silt in black clay, believed to be of Carboniferous age, at the west end of the trench at the Martley pit.

yellow quartzites along both low and high angle fault planes. He describes the Precambrian as being thrust over the Cambrian in a complex anticlinorium whose axis is exposed at Martley. It may be, however, that the faulting now seen may pre-date the main thrust episode. Groom, of course, was examining a much larger exposure and further excavation will be needed in the side trench to ascertain the true nature of the fault zone.

Together with our colleagues in the Earth Heritage Trust, the Woolhope Club members are now actively logging this important section and recording its complex range of lithologies. With thin sections of both Malvernian and quartzites, possible geochemical analyses and microfossil identification, further important information will be acquired. We all look forward to reporting further on this very special site.

(Please note that this site is on private property. Permission to visit it must be gained, in advance, from the owner.)

References:

BARCLAY, WJ and RATHBONE, PA. 1990. 'Geology of the Whitbourne district'. British Geological Survey Technical Report, WA/90/90.

GROOM, T. 1900. 'On the geological structure of portions of the Malvern and Abberley Hills'. Quarterly Journal of the Geological Society of London , Vol. 56, 138-97

MITCHELL, GH, POCOCK, RW and TAYLOR, JH. 1962. 'Geology of the country around Droitwich, Abberley and Kidderminster'. Memoir of the Geological Survey of Great Britain.

MURCHISON, RI. 1839. 'The Silurian System'. London

****

Continued from page 5.

The entrance to the disused lead mine.

crustal plates are constantly on the move, so that stresses and strains result, both compressive and tensile, with the tensile variety being key to the formation of mineral veins since these create the requisite cracking. Mineral deposits within the veins have been precipitated from hydrothermal fluids (superheated groundwater, or brine) circulating under pressure at depth and containing a considerable range of elements leached from these rocks. Tensile conditions released these fluids which then migrated via the cracks, cooling as they rose and so losing their ability to retain their dissolved contents. Depressurisation and/or chemical reaction with some rock types led to deposition of the minerals, and sometimes there was violent reaction with the country rock, the walls of which literally exploded with great force, thus filling the void with 'mineralised vein-breccia' - as was observed at this particular location.

Globally, throughout geological time there have been periods, differing from place to place, when one or other force was predominant. For us, suitably tensile conditions were experienced from the mid-Devonian until mid-Carboniferous times, and again following the Permian when conditions became exceptionally favourable during the Triassic and Jurassic rifting. In the Central Wales Ore Field detailed mineralogical dating studies indicate about a dozen such phases of pronounced mineralisation as having occurred in the mid-Devonian, Lower Carboniferous and Permian times - and the results of isotopic dating accords well with the stress patterns suggested above. Younger episodes are as yet undated, but are probably of Mesozoic age.

Location 7: Disused Quarry - near Elan village.
(SN 925 646)

Back to the turbidites for our final visit! Within the Llandovery to Wenlock succession of Central Wales, four 'basinal system types' regimes have been postulated; of these, we were here concerned with the earliest phase of what is postulated as pertaining to the 'Latest Hirnantian-early Telychian easterly-supplied mudstone slope apron systems'. The west-facing quarry face displays the customary sequence of mudstones but, near the floor of the quarry, these are replaced by a remarkable band of conglomerate comprised of massive clasts. This is a part of the Caban Conglomerate Formation. Bill explained that this massive conglomerate, together with the neighbouring Ystrad Meurig Grits, represents the pathway for a westward flowing spread of high velocity detritus from a source, as yet unknown but somewhere to the east. Furthermore, the putative canyon that must have supplied this detritus has not been identified, possibly due to displacement along the Tywi Lineament.

Then the heavens opened and, having thanked our guide for a splendid weekend, the bedraggled participants shed their rainwear, boarded their vehicles and made their departures; and, in my case, the car boot was ballasted with a large souvenir boulder of conglomerate.

CHANGING ROCKS, CHANGING IDEAS : 200 YEARS OF METAMORPHISM

Richard Edwards

THE OBJECTIVE of this article is to trace the evolution of ideas concerning metamorphism from the late 18th century up to the present day. Early geologists were able to observe sedimentary and volcanic processes and draw conclusions which could be applied to their interpretation of rocks. Metamorphic processes take place beyond the realm of direct observation and are therefore more problematic. Thus, it took nearly two hundred years for a full understanding of metamorphism to develop.

One of the first British geologists to recognise the role of heat in controlling geological processes was James Hutton (1726-97). Hutton was born in Edinburgh and studied Medicine but abandoned this profession after inheriting a farm in Berwickshire. His travels to investigate innovative farming methods led to a developing interest in rocks and he became one of the founding fathers of Geology.

Hutton made two major contributions to our understanding of Earth processes.

Firstly, his observations at Siccar Point and other localities in Scotland led him to appreciate the great lengths of time required for Earth history. This was expressed in the famous dictum "No vestige of a beginning, no prospect of a end".

Secondly, Hutton argued that the Earth was a dynamic system controlled by an "unknowable" source of heat at depth. His theory of granite being emplaced as a molten material was confirmed by field visits to localities such as Glen Tilt, where granite veinlets were observed cutting across sediments. Later Hutton wrote "We may now conclude that, without seeing granite actually in a fluid state, we have every demonstration possible of this fact; that is to say of granite having been forced to flow, in a state of fusion, among strata broken by the subterranean force and distorted in every manner and degree."

Hutton's ideas culminated in his ‘Theory of the Earth’ - first presented as a paper to the Royal Society of Edinburgh in 1785. Hutton's arguments effectively destroyed the Neptunist viewpoint, advocated by Werner, which interpreted all rocks as having been deposited from a large ocean.

Charles Lyell (1797-1875) was also hugely influential in contributing ideas to the developing subject of Geology. Perhaps his most important legacy is his belief that Geology could best be understood by observing processes taking place at the present day - the present is the key to the past. Lyell was also one of the first geologists to recognise the significance of metamorphism. In 1843 he married Mary Horner and their honeymoon had a distinctively geological flavour. The newlyweds travelled through Germany, Switzerland and Italy where Lyell met prominent European geologists and visited key sites following their recommendations. Of particular importance was the work carried out in Switzerland by Studer who demonstrated that sedimentary rocks passed without any distinguishable boundary into slaty rocks known as schists. Studer's interpretation had been influenced by the Genevan naturalist, Necker de Saussure, who had observed granite veinlets penetrating fossiliferous sedimentary rocks at a locality called Vallorcine in the Chamonix valley, which Lyell visited. It was from his observations at Vallorcine that Lyell created the new class of metamorphic rocks.

In 1871 Lyell set out his views on metamorphism in his textbook "Elements of Geology". It was a fairly defensive coverage of the subject and clearly the concept had not received universal acceptance. Lyell began by listing the main types of metamorphic rock: gneiss (a term which was derived from usage in German mines), mica schist, hornblende schist, metamorphic limestone, quartzite and clay-slate.

Lyell also established that although metamorphism could best be demonstrated at the margins of granite intrusions, metamorphic rocks could be demonstrated over 'vast dimensions', citing Norway as an example.

The important roles played by Hutton and Lyell are widely acknowledged but the vital contribution of Henry Clifton Sorby (1826-1908) is largely forgotten. Sorby was born into a prosperous middle class family in Sheffield and studied at home with a tutor. When he was twenty-one his father died leaving him with a comfortable private income. He established a laboratory and workshop in his home and devoted the rest of his life to scientific research. Sorby's main geological achievement was in the development of petrographic techniques and in particular the production of thin sections - translucent slices of rock which permit their mineralogy and texture to be assessed under a microscope using polarised light. This was a huge advance in the study of rocks and perhaps especially metamorphics. For example, in 1877 Rosenbusch was able to use petrography to illustrate the mineralogical and textural changes within the contact aureole of the Barr-Andlau granite massif in the Vosges.

Metamorphism entails not only mineralogical change but also structural modification of the parent rock. Adam Sedgwick (1785-1873) was one of the foremost geologists working on this problem in the middle of the 19th century and his structural studies were focussed on the complex Transition Rocks in North Wales. Sedgwick's fieldwork culminated in his definition of the Cambrian System as the stratigraphic position of these Transition rocks in the face of bitter hostility from Murchison and the general disbelief of most of the geological community. Sedgwick's key insight was the recognition that slaty cleavage was a metamorphic fabric, unrelated to bedding within the original sedimentary rock. This had profound implications both in

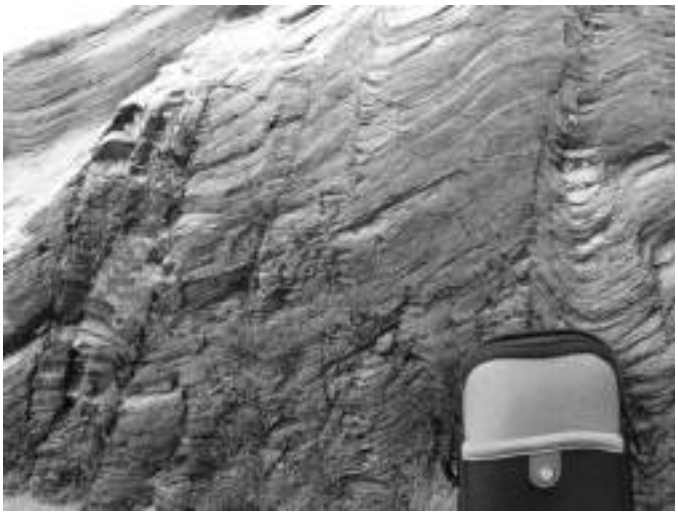


Fig. 1 : Steeply inclined cleavage over-printing sub-horizontal bedding in Devonian argillites. (Carne, near Nare Head, Cornwall. Camera case is 7cm wide)

interpreting the stratigraphy of an area but also in showing how the original sedimentary structures of a rock could be progressively changed to a slate and ultimately to a gneiss (Fig. 1). Sorby also contributed to this debate and was able to apply his new petrographic technique to the problem to demonstrate the mineralogical changes associated with slaty cleavage. At this stage, most geologists accepted that fine-grained sediments might be altered to slates. However, very few were prepared to accept that schists, gneisses and ultimately granites might be stages in a progressive sequence of metamorphism. Although Werner's Neptunean ideas had been largely discredited, most geologists still clung to the belief that all granites and gneisses represented the fundamental base of the Earth's crust.

Ironically, Darwin, who we think of as a zoologist, had many perceptive insights into geology including the belief that slaty cleavage was a re-crystallisation phenomenon and that a spectrum of metamorphic rock types extended from slate to gneiss.

During the latter part of the 19th century the French geologists Jean-Baptiste Elie de Beaumont (1798-1874) and Gabriel Auguste Daubrée (1814-1896) recognised two main types of metamorphism and introduced the terms 'Contact' and 'Regional' to describe them. However, this was not immediately accepted by the geological community. For example, Lapworth, who had worked on metamorphic rocks in the NW Highlands of Scotland, believed that contact metamorphism could be developed on a gigantic scale and Barrow, working in the Grampians, stated that he could not discern much difference between the two types. Both Lapworth and Barrow were geologists of outstanding ability but remained sceptical about a classification which is taken for granted today.

In the mid 19th century a bitter dispute arose concerning the age of the rocks underlying the NW Highlands of Scotland. The main protagonists were Roderick Murchison and Archibald Geikie, respectively Heads of the English and Scottish Geological Surveys, on the one side and James Nicol and Charles Lapworth, both academics, on the other. Murchison and Geikie believed that the rocks formed a continuous easterly dipping series which could be assigned to the Silurian System.

Lapworth and Nicol correctly argued that thrust faults had moved older Moine rocks on top of Cambrian sediments. Murchison and his co-workers had incorrectly interpreted thrust planes as bedding planes, a mistake unlikely to have been made by Sedgwick. This controversy was eventually solved by the classic mapping of legendary Survey geologists Peach and Horne, supported by petrographic work carried out by Survey specialists. One of the side effects of this dispute was that much of the effort of the Geological Survey in the late 19th century was channelled towards resolving this problem. Meanwhile the Geological Survey's B team were trying to interpret the complex metamorphic geology of the Grampians.

The team of geologists assigned to work out the complex metamorphic geology of the Grampians had a hard task ahead of them. In metamorphic terrain it was very difficult to apply the conventional mapping techniques which had been developed in sedimentary sequences. Nonetheless, one of the most important developments in our understanding of regional metamorphism arose from this mapping exercise.

George Barrow (1853-1932) is now recognised as the outstanding member of the team who mapped the Grampians. Barrow had served a somewhat unusual apprenticeship as private secretary to the eminent vulcanologist Poulett Scrope, where his duties had included reading aloud to the elderly Scrope for six hours each day. Scrope recommended Barrow to Ramsay, then Head of the Geological Survey, who duly appointed Barrow as a Survey geologist following the death of Scrope in 1876.

Barrow's great achievement was in recognising that metamorphic minerals, such as kyanite and sillimanite, could be used to map distinctive zones within the otherwise uniform sequence of metamorphic rocks (Fig 2). The foundations had been laid for the study of progressive regional

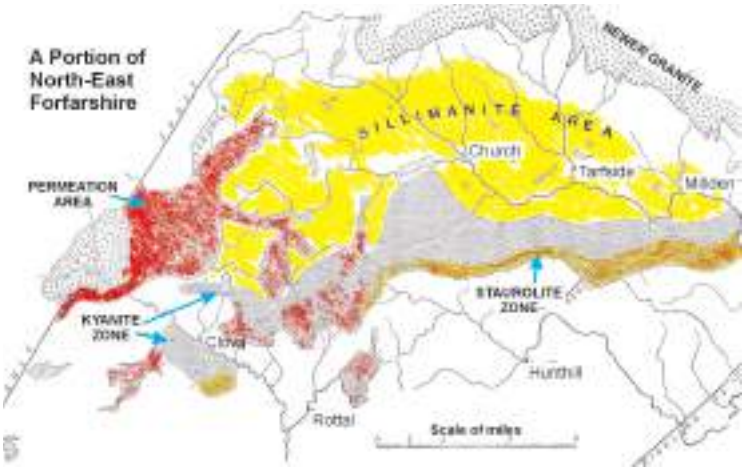


Fig. 2 : Barrow's geological map of NE Forfarshire showing the distribution of metamorphic minerals. (Modified from G Barrow 1893, 'On an intrusion of muscovite-biotite gneiss in the south-eastern Highlands of Scotland and its associated metamorphism', Quart. Journ. Geol.Soc. vol xlix, pp330-358. Reproduced by permission of the Geological Society)

metamorphism. However, Barrow failed to recognise that the granite, which he had interpreted as intrusive, actually marked the final step of regional metamorphism, the stage when melting begins. This type of rock, which is a variable mixture of granite and high-grade gneiss, is termed a migmatite and was first recognised by the Finnish geologist Jakob Sederholm (1863-1934) early in the 20th century.

Barrow's achievement was not immediately recognised by his fellow geologists. However, his use of metamorphic minerals to define zones of progressive metamorphism was taken up by Tilley in the 1920s and 1930s and extended to a wider area of Scotland. WQ Kennedy continued Tilley's mapping and discovered that when allowance is made for the 65km displacement of the Great Glen Fault a consistent pattern of mineral zones could be determined. Kennedy pointed out that the pattern of mineral zoning could be interpreted as a thermal anticline pitching to the south-west (Fig. 3). Kennedy interpreted the thermal anticline as a consequence of downbuckling of the continental crust during orogenesis, with partial melting and migmatisation at depth and an associated pattern of prograde regional metamorphism (Fig. 4).

I have already discussed the important work carried out by Barrow, which was later extended by Tilley and Kennedy. This approach has limitations because Barrow's indicator minerals of metamorphic grade are mainly developed in rocks which started their lives as muddy sediments with a high clay content. Barrow's metamorphic minerals are therefore characterised by a high alumina content. However, there are many rock types which lack this initial chemistry and so re-crystallise during metamorphism to different minerals.

The Finnish geologist Pentii Eskola (1883-1964) devised an approach which resolved this problem. Eskola recognised that different rock types tend to recrystallise into distinctive mineral assemblages which are defined in part by their original chemistry and in part by temperature/pressure conditions. In 1921 Eskola introduced the concept of metamorphic facies and provided a qualitative method by which a particular metamorphic mineral assemblage could be placed within a temperature/pressure grid.

Since the 1950s enormous advances have been made in our understanding of metamorphic reactions and the regional tectonic setting of metamorphism. A key advance has been in defining the temperatures and pressures of metamorphic reactions. This was initially worked out by VM Goldschmidt (1885-1947) at the age of twenty-three using thermodynamic data to create the equilibrium curve for the creation of the metamorphic mineral wollastonite. However, most of our knowledge concerning the parameters of metamorphism has come from major laboratories in the USA in which small quantities of low temperature minerals are subjected to a range of temperature and pressure conditions and then examined by X-ray diffraction techniques to determine the nature of the new metamorphic mineral. A key landmark was the accurate determination of the andalusite/kyanite/sillimanite triple junction which proved that partial melting of metamorphic rocks could take place within the temperature/pressure range of crustal conditions.

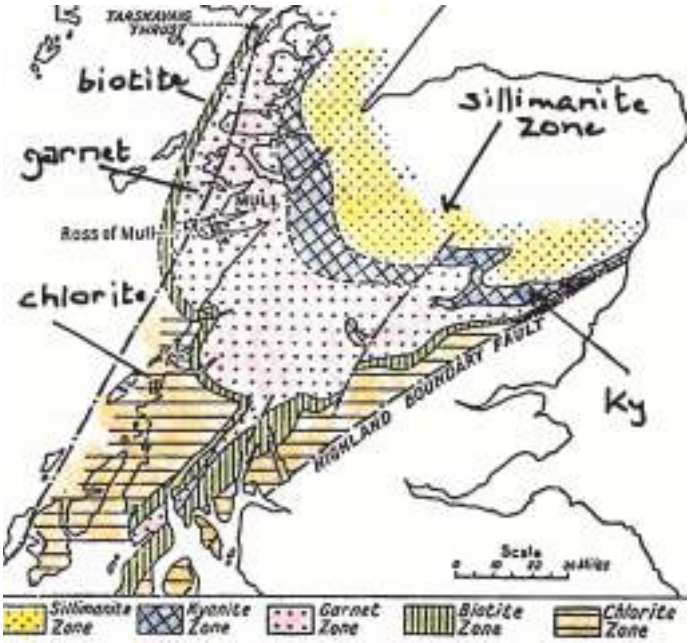


Fig. 3 : Kennedy's thermal map of the Scottish Highlands, based partly on the work of Barrow, Tilley and Elles. The map is corrected for 65km of lateral displacement along the Great Glen Fault. *(WQ Kennedy 1948, 'On the significance of thermal structure in the Scottish highlands', Geol Mag, 85(4), pp229-234. Reproduced by permission of the Cambridge University Press)*

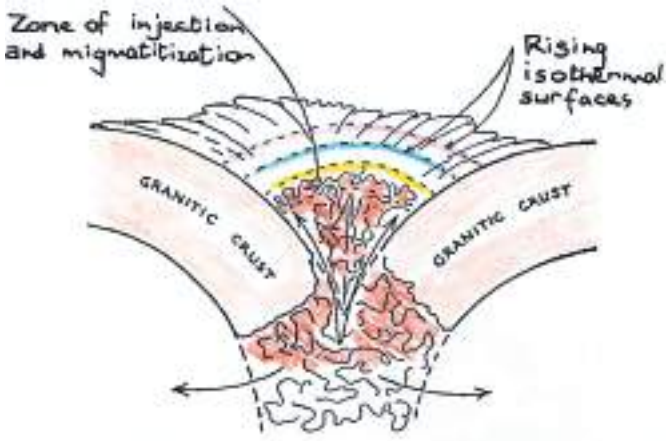


Fig. 4 : Kennedy's interpretation of the metamorphic zones as a thermal anticline associated with a tectogenic 'root'. *(WQ Kennedy, loc. cit. Reproduced by permission of the Cambridge University Press)*

The development of plate tectonic theory in the 1960s has finally allowed metamorphism to be placed in its regional tectonic context, nearly two hundred years after Hutton made his astute field observations at Glen Tilt. We might take Miyashiro's textbook "Metamorphism and Metamorphic Belts, published in 1973, as marking an approximate 200 year milestone. If there is a pattern to be observed in this long history of ideas it seems to be characterised by brilliant minds making astonishing discoveries, followed by some decades of indifference before their significance is recognised by the wider geological community. Geological prophets are not always recognised in their own lifetime.

Anatomy of a landslip: the Darens, Olchon Valley

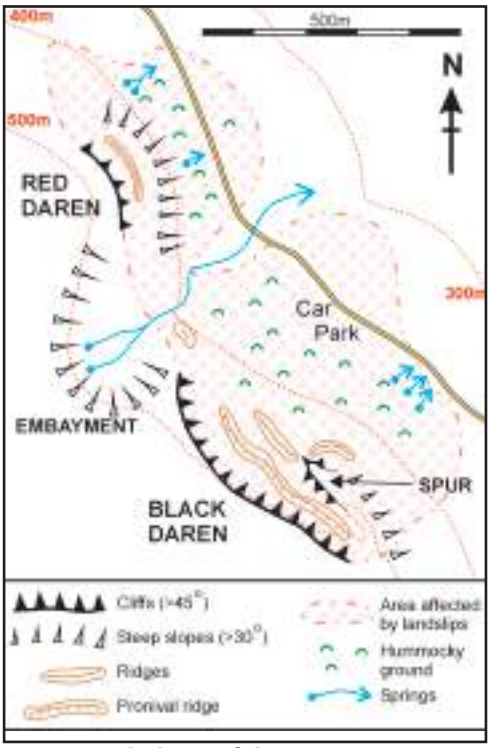
Professor Richard Bryant

BLACK DAREN AND NEARBY RED DAREN are two intriguing landscape features overlooking the Olchon valley on the eastern edge of the Black Mountains. Here we can see impressive evidence of large-scale rock slope failure (RSF), which most likely represents a landscape adjustment to former glacial erosion of the slopes. There are also landforms nearby which are related to periglacial (cold climate) conditions. This assemblage of mountain features is unique within Herefordshire, although similar landforms occur over the border in Wales.

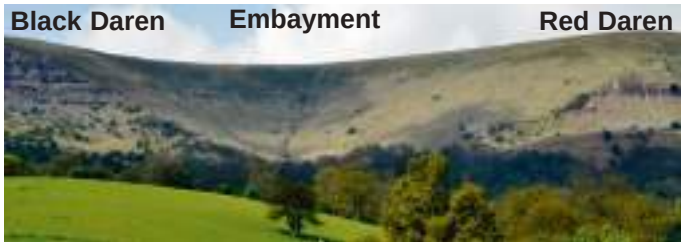
Black Daren with the pronival ridge and hummocky ground in front and the spur to the left.

The geomorphological map depicts features typical of a semi-intact large scale slide. At Black Daren, there is a distinct headscarp (the multi-ledged cliffs), accompanied by evidence of extensional forces in the form of vertical fissures, small graben, and lateral tension cracks which are still observable today along the top of the precipice. Below the headscarp there is a depositional sequence consisting successively of: scree, ridges, and antiscarps (ridges with their scarp facing uphill), all nearest the seat of failure; a middle section composed of more chaotic terrain; and a lower part (mainly below the mountain road) with more subdued, long travel features indicative of soil and rock flowage. Red Daren has some similar characteristics but the depositional sequence is simpler.

Among the most interesting features at Black Daren are the spur, the scarpfoot ridge, and the embayment. Investigations of the rock sequence suggest that the spur is probably largely intact, although it exhibits a number of minor displacements associated with RSF. The scarpfoot ridge (see photograph on p.7) appears to have a complex origin, and is at least in part a pronival rampart, formed at the foot of a large semi-permanent snowbank. The embayment between the two Darens may have harboured a cirque (cwm) glacier in the last (Devensian) glacial period. It faces north-eastwards, which would have afforded it maximum protection from insolation, and it would have been in a good position to receive snow blown from the west, off the present-day Offa's Dyke ridge.



Geomorphology of the Darens.



The Darens from the road.

Several key factors are likely to have contributed to incidence of landslips at the Darens. First and most crucial is the lithological set-up. The lower slopes are largely comprised of the relatively soft terrestrial mudstones of the St Maughans Formation; most modern-day springs in the Olchon valley are to be found here. The upper slopes consist of the massively bedded sandstones of the Senni Formation. This arrangement readily provides potential slip-plane surfaces for the collapse of the competent rocks over the weaker ones. A second factor is the weakening of the lower strata by consistently high pore water pressures, most prevalent under cold-climate (periglacial) conditions. The soliflucted mantle in the upper valley is one indicator of such conditions. Thirdly, the Olchon valley has an open, glaciated aspect, and it seems very likely that the slopes at the Darens have been oversteepened at some time in the past by glacial erosion - in effect, they are shorn valley-side buttresses - and this process was significant in providing the potential for slope failure.

It is difficult to be precise as to when the main landslips occurred but it must have been after the last phase of glacial and periglacial activity. The landslips have the 'freshest' depositional landforms in the Olchon valley, and cut into the soliflucted slopes on either side. Most probably, by analogy with similar features studied in Scotland, major slope failure took place at the end of the Devensian or in the early Holocene. Although some small-scale slope adjustments are still taking place, the landslips at the Darens can be regarded as essentially arrested.

Members of the WGS Committee

(December 2010)

Gerry Calderbank ***Chairman***

Dr Geoff Steel ***Vice-Chairman***

Dr Paul Olver ***Secretary***

Beryl Harding ***Treasurer***

Dr Sue Hay ***Programme Secretary***

Moira Jenkins ***Section Recorder***

Kate Andrew ***Heritage Services Representative***

Dr John Payne ***'Earth Matters' Editor***

Charles Hopkinson

Herefordshire Heritage Services

THE PUBLIC are slowly learning of our curatorial drop-in days on the second Thursday and third Tuesday of the month. We now get most of our enquires this way, allowing people to get on-the-spot answers and the chance to compare items with those in the collection.

Our big activity days this year have both been successful partnership events, attracting close to 200 people to each day. The Earth Heritage Trust joined us for 'Volcano!' on 15th April - the day that the Iceland Volcano chose first to disrupt air traffic. Many of the EHT and our own volunteers are also WGS members, so the club was well represented in person as well as with its display.

'Digging up the Celts', our event for Archaeology Day in July also saw the Overlooking the Wye project represented. We plan to run a geologically themed open day again in the next Easter holiday, again in partnership with EHT.

We are currently working on an on-line catalogue that will eventually allow the collection records to be available on-line. Currently a sub-set of geology and biology specimens is being chosen - we have some challenges to overcome as all types of object from our collection are on the database and the fields of data don't necessarily work well between man-made and natural objects. Look out for this in December.

From January to Easter 2011 we are once again running a series of seminars in partnership with WEA. The history of geology in Herefordshire session will be re-run as an evening session, so you have second chance to come and see historic material in the collections and the research Kate has been doing for the club's book on the Geology of Herefordshire.

The paper catalogue of the geology collection is completed and we are now entering location codes and checking through the drawers to make sure all specimens are recorded. We would be very glad of help from a computer-literate, geologically aware volunteer in inputting this data onto the specialised collections database. Please get in touch with me (01432-383590, kandrew@herefordshire.gov.uk) if this appeals.

Katherine Andrew

H&W Earth Heritage Trust

THIS YEAR'S GEOPARK GEOFEST was a great success with over sixty events between May and August. These ranged from 'Ask the expert' in both Geology and Archaeology, through guided walks and roadshows to a 'Creepy Crawlies safari' in the Wyre Forest. Next year's programme is now being developed along similar lines. It should be on the web site (www.geopark.org.uk) in the spring .

The Malvern Walking Festival again featured several sections of the Geopark Way. These walks were strongly supported and there are plans to include some more sections in next year's programme. Over 1300 copies of the Geopark Way guidebook have been sold and an excellent geological map of the Geopark is near completion.

The EHT was very successful in the last round of the Aggregates Levy Sustainability funding and has completed a feasibility study on the future use of Broadway quarry in Worcestershire, which will cease being a working quarry by the end of this year. We are now planning to implement the findings of the study.

Another programme will improve the quality and access to information on the aggregate resources of Herefordshire and Worcestershire, through the creation of a new Geodiversity Database and auditing of aggregate sites across both counties. In addition, Geopark Way 2 is devising an aggregates booklet and trails as well as developing a Volunteer trail watch scheme. Due to the success of the 'Introduction to Geology' course offered to these volunteers, the Trust will run two similar courses this autumn, one in each county, which will be open to the public.

The Champions programme has recruited nearly seventy Champions who are learning about both geology and the skills needed to maintain their own sites. Many sites have held launch events over the summer. Dingle Quarry, for example, is now bramble free, making it much easier to see all the igneous rocks.

Sue Hay, *EHT Chairman*