Earth Matters

The Newsletter of the Geology Section of the Woolhope Naturalists' Field Club

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MESSAGE FROM THE CHAIRMAN

AT OUR AGM this year I took over from Gerry Calderbank who has been our Chairman for six years. I'm sure you'll join me in thanking him for his dedication and hard work. Gerry is staying on the committee as Vice-Chairman so I can draw on his advice when needed.

With a background in electronics and acoustics I feel somewhat under-qualified for a role in geology and I hope that my enthusiasm can make up for my limited knowledge. I grew up in the Chiltern Hills in Buckinghamshire. Scenically they are very beautiful but under the soil is just chalk, chalk and more chalk. What a delight I've found on moving to Herefordshire – within walking distance of my house (near Kington) I have Precambrian, Silurian and Devonian rocks, and a short drive adds Ordovician as well. Not only that but the folds, twists and contortions of the Church Stretton Fault throw these rocks into a wonderful confusion of prominent hills and secret valleys. It is a geological heaven. Hence I am keenly looking forward to the publication of our book on Herefordshire geology. The book is aimed at those who have an interest but are not specialists, in other words people like me.

Over the last few years my main job on the committee has been to write up our talks and field trips for 'Earth Matters'. Apart from forcing me to take careful notes (a great way to learn the subject) this has also made me aware of the hard work that Sue Hay does in finding the speakers. We are lucky that she makes time to do so. I want to thank her and all the committee for giving their time and energy, and I welcome Tony Geeson who has joined us recently. **Geoff Steel**, *Chairman*

A pseudoanticline structure on Merbach Hill (see p.14)

EARTH HERITAGE TRUST CONTRIBUTION TO THE WYE VALLEY PARTNERSHIP PROJECT 2012-3

Moira Jenkins

About the Project

The Wye Valley Partnership Project is sited on the lower catchment of the River Wye in an approximate triangle between Monmouth, Hereford and Hay-on-Wye, the area of an unsuccessful Nature Improvement Area (NIA) bid. The project, funded by DEFRA through Natural England, aims to protect, maintain, enhance and restore biodiversity and geodiversity of the Wye Valley.

Herefordshire and Worcestershire Earth Heritage Trust (EHT) undertook to produce the following outputs as part of the Wye Valley Partnership Project.

1. Geoconservation work at four sites to restore rock faces and habitats
2. A management plan for a Local Geological Site (LGS, formerly called a Regionally Important Geological Site, RIGS).
3. A baseline audit of geodiversity, soil, glacial and fluvial features.
4. Designation of six new LGSs (see following article)
5. Lead two guided geology and landscape walks.
6. An education pack describing geodiversity and fluvial features of the Ross-on-Wye area.

Many volunteers helped to make this project a success. This article describes briefly only the site clearance and walks, items 1 and 5 above.

Site Clearance

Rudge End Quarry (SO 588 353)

Clearance work was carried out at Rudge End Quarry, a Local Geological Site which is also a Nature Reserve managed by Herefordshire Nature Trust and owned by the Forestry Commission, on the Woolhope Dome less than a mile northeast of Fownhope. Rudge End Quarry is one of the sites which is part of the Community Earth Heritage Champions Project, http://champions-earthheritagetrust.org.

Rudge End Quarry. Left: Main face before clearance. Right: The cleared rock face and stinking hellebore

Sites on Little Doward

The sites to be cleared were agreed with the Woodland Trust. These are also Champions Sites and the ‘Champion’ was involved. Two of the sites are LGSs and the third is a potential site for designation.

A small quarry in the Tintern Sandstone, behind the crag of Quartz Conglomerate, was cleared to show the overlying Tintern Sandstone, which is now visible as a band across the back of the quarry. (SO 5359 1569)

A previously unexposed junction between the Lower Limestone Shales (Avon Group) and the Lower Dolomite (Black Rock Limestone) was uncovered on the hillside. (SO 5390 1578)

The Limestone Pavement in Crease Limestone (Gully Oolite), a site high on the hillside of Little Doward, was almost completely obscured by brambles, ivy and nettles. (SO 5415 1579)

The rock face was uncovered along the front of the pavement and with some clearance of the upper surface. The clints (pavement surface) and grykes (clefts in the rock) are now clearly visible along a 10m section. Many interesting features were uncovered showing how the rock is gradually eroded into runnels and tiny sink holes. Lime-loving plants now have the opportunity to become established. There were already a few but they were smothered in undergrowth.

An exciting discovery was made at the end of the day, when Tom Richards found a fine fossil, yet to be identified. This appears to be a cup (theca) of a crinoid or a colonial coral.

This site is now a clear example of a limestone pavement and is an excellent site for educational visits. Clearance work has provided an opportunity for specialised lime-loving plants to become established now that they are not smothered in brambles and ivy.

The Little Doward limestone pavement before clearance and part of the cleared surface of the pavement.

Irregular deposits of calcareous tufa coating the cliffs at the Biblins

The Devonian Quartz Conglomerate outcrop.

Guided geology and landscape walks

Both walks were on rather dull days. **The Hampton Bishop Walk** on 9th March 2013 was one which some members of WGS did in the autumn. Participants looked at the 'Stank', the flood defence barrier by the River

Moira describes the limestone pavement.

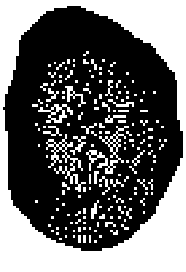
Lugg and walked around a meander of the River Wye with a stop for lunch at the Bunch of Carrots. As well as the fluvial features seen, biologists were able to point out fresh water mussels and mistletoe. **The Wye Gorge Walk,** 16th March 2013, descended to the river cliffs at the Biblins, which are being coated by calcareous tufa. This is deposited from solution in water pouring down the cliffs from Dropping Well above. It is an irregular rock full of holes and inclusions of pieces of twig, leaves, and beetle carapaces.

We stopped for lunch at the first of the crags on the hillside, which shows the Quartz Conglomerate. This spectacular rock with pebbles set in a finer matrix was deposited from a flash flood about 400 million years ago and was the older of the rocks seen on the walk.

On the way across Little Doward hillside we walked past younger and younger rocks – Tintern Sandstone and then the Carboniferous Limestone layers. We stopped to look at three of the sites where clearance had taken place as part of this project. The last of these was the limestone pavement near the top of the hill. Here one of the walkers found a new fossil, a gastropod, a snail shell, which had not been recorded there before.

The walk finished at King Arthur's Cave and a line of limestone cliffs with an undercut base and caves eroded by flowing water, which is no longer at this level.

'*Palaeosmilia*' by Archie Lamont



Archie Lamont (1907-1985) taught geology at Birmingham University in the 1940s. He published two papers on the Llandovery fossil fauna of the Alfrick area. He was also a poet and an ardent Scottish Nationalist. Here are some lines suggested by corals seen on a gravestone of Carboniferous limestone. Weathering had obliterated the name of the grave's occupant but revealed the much more ancient *Palaeosmilia* coral fossil in great detail.

(A Lamont. 1943. 'Patria Deserta', Oliver & Boyd, Edinburgh, p. 60.)

Two hundred years did the dark limestone hold
A script, but all the letters have been lost ;
The dead lie nameless. Acids of the mould,
Sharp agencies of wind, crystals of frost,
The drifting rain, the sun, and winter cold,
Splintering tightest atomies apart,
Shew forth the hidden threads of corals old,
On the smooth stone traced with minutest art.
Over the myriad centuries between
Nature remains thus faithful to her own,
Dissepiments like a thin veil are seen
About the theca of the hollow cone,
Calyx, tabulae, septa live again.
Longer than bones and epitaphs of men.

GEOLOGICAL SITES IN THE WYE VALLEY

Tom Richards (ex-EHT)

OBJECTIVE no. 4 of the Wye Valley Partnership project (see previous article), carried out by the Herefordshire & Worcestershire Earth Heritage Trust, aimed to explore and discover more about the wonderful geological heritage of Herefordshire. Six new sites were to be designated as LGSs (Local Geological Sites). A few of the geological gems that were uncovered during the project are briefly described below. Others included a new exposure of limestone pavement, the uncovering of the lower boundaries of the Tintern Sandstone and the Lower Dolomite beds and an exposure of the Cromhall Sandstone, all on Little Doward, and a site at Holme Lacy showing terrace gravels of the River Wye.

Huntsham Hill (SO 562 168)

Located at the northern edge of the Forest of Dean Plateau, Huntsham Hill sits on the narrow neck of a large meander of the River Wye, half a mile north of Symonds Yat Rock. The Wye Gorge, which surrounds the hill, is one of Britain's most famous landscapes and beauty spots. Whilst many visitors will stop at the wonderful viewpoint of Yat Rock, unbeknown to them the tree-covered ground they gaze across hides some of the more intriguing and yet little studied geology in the entire Wye Valley.

Desiccation cracks on Huntsham Hill

Site 1. The Lower Devonian Brownstones Formation lies at the northern base of the hill. This chocolate-brown-coloured sandstone forms much of the ground of the Herefordshire lowlands and is informally grouped into the 'Old Red Sandstone' series. Overlying the Brownstones is the Upper Devonian Quartz Conglomerate Formation, locally known as 'Pudding Stone' or 'Great Plum-Pudding Stone'. This rock is a red-brown, medium- to coarse-grained, pebbly sandstone with thick beds of fining-upwards quartz pebble conglomerate. Whilst quartz is the main constituent, quartzite, igneous rocks and jasper clasts are also present. The rock forms a spectacular and easily traceable line of crags around the northern slope of the hill. Huge detached blocks are often found downslope from the exposures, as weathering along joint planes has resulted in sporadic rock falls. In addition, at one locality on the hillside the base of an overhanging section reveals what may be a unique feature along the entire outcrop; desiccation cracks. These originated when a sudden influx of sediment filled the cracks on a dried and hardened mud surface. Solidification of the wet sediment and the recent erosion of the soft mudstone beneath has revealed the casts of the cracks on the bottom surface of the upper rock. The structures are up to 50cm in diameter, with fossilised cracks up to 7cm deep. Because the Quartz Conglomerate formed in a high energy environment, preservation of desiccation cracks would have been very rare, making their presence extremely interesting and important. No other locality that contains such obvious and accessible features is known along the entire outcrop of the Quartz Conglomerate. (SO 5592 1667)

Crag of Quartz Conglomerate near the road north of Symonds Yat. The desiccation cracks are in the overhang.

Site 2. (SO 5623 1648) The boundary between the Quartz Conglomerate and the overlying Tintern Sandstone Formation is conformable. It marks a subtle change in sedimentation as conditions quietened and shifted from the ephemeral flood events that formed the Quartz Conglomerate to a more stable lowland alluvial environment in which the Tintern Sandstone was deposited. Hidden away in the woodland that caps the narrowest point of the meander neck, a hitherto unknown (and arguably one of the best), sections in the Tintern Sandstone along the entire Welsh Borderland was discovered during the project.

A lower exposure some 60m long shows three metres of southerly dipping red-brown, poorly sorted sandstones with quartz pebbles scattered throughout. Many sedimentary features are seen including cross-bedding, planar lamination, erosion surfaces, rip-up clasts and channelisation. Visitors might ask whether they are looking at the upper beds of the Quartz Conglomerate or the lower beds of the Tintern Sandstone.

An upper level some 30-40m to the south comprises over

5m of buff, orange-brown and grey, fine to medium, calcitic sandstones, interbedded with grey siltstones. This is what is more typically associated with the Tintern Sandstone. Structures seen include parallel lamination, irregular erosive surfaces and hematite mineralisation.

The Tintern Sandstone on Huntsham Hill.

On a visit to the section in July 2013 by project volunteers keen to take a further look post-project, a sign that yet something more was happening along this section was discovered. Along the upper level crinoid ossicles were observed *in situ*, within thin beds of limestone. Crinoids are marine animals and so this bed must originate from one of the several short incursions by the sea which mark the start of the following Carboniferous period. The Devonian-Carboniferous boundary is transitional in the Welsh Borderland and records a major, yet pulsed, transgression from an alluvial to a fully marine environment. It is however also one of the most difficult boundaries to identify due to its pulsed yet conformable nature. The crinoid evidence suggests that this exposure may reveal a continuous succession through the Devonian-Carboniferous boundary; one of only a few such localities nationwide.

Credenhill Park Wood Adit and Quarry (SO 448451)

A series of hills is scattered along the flanks of the River Wye as it winds its way across central Herefordshire, through the Old Red Sandstone country. These hills are capped by beds of the Devonian St Maughans Formation, with the lower ground of the Wye Valley underlain by the Silurian Raglan Mudstone Formation. Between these two units is the impersistent Bishops Frome Limestone (‘cornstone’ and then ‘Psammosteus’ Limestone in early literature). Credenhill Park Wood is one of the so-called ‘cornstone’ hills and is situated some four miles west of Hereford. Owned by the Woodland Trust, the wooded hillside contains some interesting archaeological treasures, including one of the largest Iron Age hillforts in the country. Geologically, the woodland also holds an intriguing exposure of the Old Red Sandstone along its north-west flanks, although locating it is tricky. The approach to the site is rather inconspicuous; a small path veering off deeper into the woodland seems rather unappealing. The search is, however, very worthwhile!

The section reveals an excellent exposure of the Bishops Frome Limestone (BFL), overlain by sandstones of the St Maughans Formation. The BFL comprises a 1.5 metre thick, massively bedded limestone (appearing to have formed by the coalescence of large calcrete nodules), capped by around 0.5m of interbedded mudstone and calcrete nodules. Another 3.5m consists of blocky red mudstones with nodules, although green, grey and purple mudstones can also be seen. Altogether, the BFL is around five metres thick.

A sharp, irregular boundary at the top of the BFL marks the unconformable transition to the sandstones of the St Maughans Formation. Around 3m of well exposed grey-brown, medium- to coarse-grained, channelised, cross-bedded and cross-laminated sandstones are seen. But what should impress the visitor here is that the thick limestone bed in the BFL has been extensively worked from a shallow, arc-shaped pit that almost entirely surrounds the exposure. As if that wasn’t enough, the demand for the stone must have been so high that the quarrymen were instructed to dig an adit into the hillside to extract more! Unfortunately, the entrance is now fenced off and partially filled in with rubble, so one can no longer crawl inside. However, the British Geological Survey obtained access to the adit whilst surveying for the Hereford Memoir. Inside they recorded and photographed on the adit walls a ‘pseudoanticline’ structure, with the entire bed appearing to be gently folded with a fan-like arrangement, which lies perpendicular to wave-like fractures. The interpretation is that this may be an expression of patterned ground. Both of these unusual features have only been recorded at one other locality in Herefordshire, but which is now thought to be lost. (See pages 1 and 14 for a recent discovery of local pseudoanticlines.)

The entrance to the Credenhill limestone mine.

The above just scratches the surface on the variety of geological sites and features the Wye Valley Partnership project recorded. The Wye Valley and Herefordshire have some quite wonderful and unique geological features, albeit they may lack the stunning aesthetic qualities of other, more exotic locations. Without the hard work of the Earth Heritage Trust and its volunteers (many from the Woolhope Club), such locations which give us unique and often different insights into our geological past, may well be lost forever.

THE BRITICE-CHRONO PROJECT

Geoffrey Thomas

THE original 2005 BRITICE mapping project assembled a database of the glacial landforms of the British Isles, mostly derived from existing maps, air photos and satellite images, and produced a Geographical Information System (GIS) map showing their distribution nationwide. Although this provided a major step forward in our understanding of the extent and style of the last glaciation, the coverage was inevitably uneven and often generalised and many areas, including much of the Cheshire-Shropshire lowlands and the Welsh borderland, were sparsely featured.

BRITICE-CHRONO, the successor to BRITICE, is a current five-year NERC-funded consortium of ten universities, led by Sheffield University, in collaboration with the British Geological Survey, the Geological Survey of Ireland and the British Antarctic Survey. Its aim is to improve on the mapping by using modern remote-sensing methods in both lowland drift and highland rock-cored areas. A significant innovation is to extend the mapping out across the continental shelf using ship-based multi-band sonar. Until recently the limits of the last (Devensian) glacial maximum, the LGM, were considered to extend only a short distance off-shore. Recent investigations, however, have established that the limits extend right to the continental edge off north and north-west Scotland and western Ireland, where major moraine systems, ice-streaming bedforms and drumlin swarms have been identified.

The project aims to identify all the glacial features, onshore and offshore, occurring within revised LGM limits, to identify retreat stages, usually from the definition of major moraines, and to date these stages. Dating samples will be obtained by seabed drilling and quarry exposure and rock outcrop. The project will provide data to construct a chronologically constrained, three-dimensional dynamic model of the collapse of the last glaciation over time. Such a model should make the British and Irish Ice-Sheet (the BIIS) the most detailed and well-constrained former ice-sheet model in the world and will be used for the improvement and calibration of computer models forecasting ice volume changes in contemporary ice-sheets, such as the Greenland and the Antarctic, as they retreat under the influence of climate change.

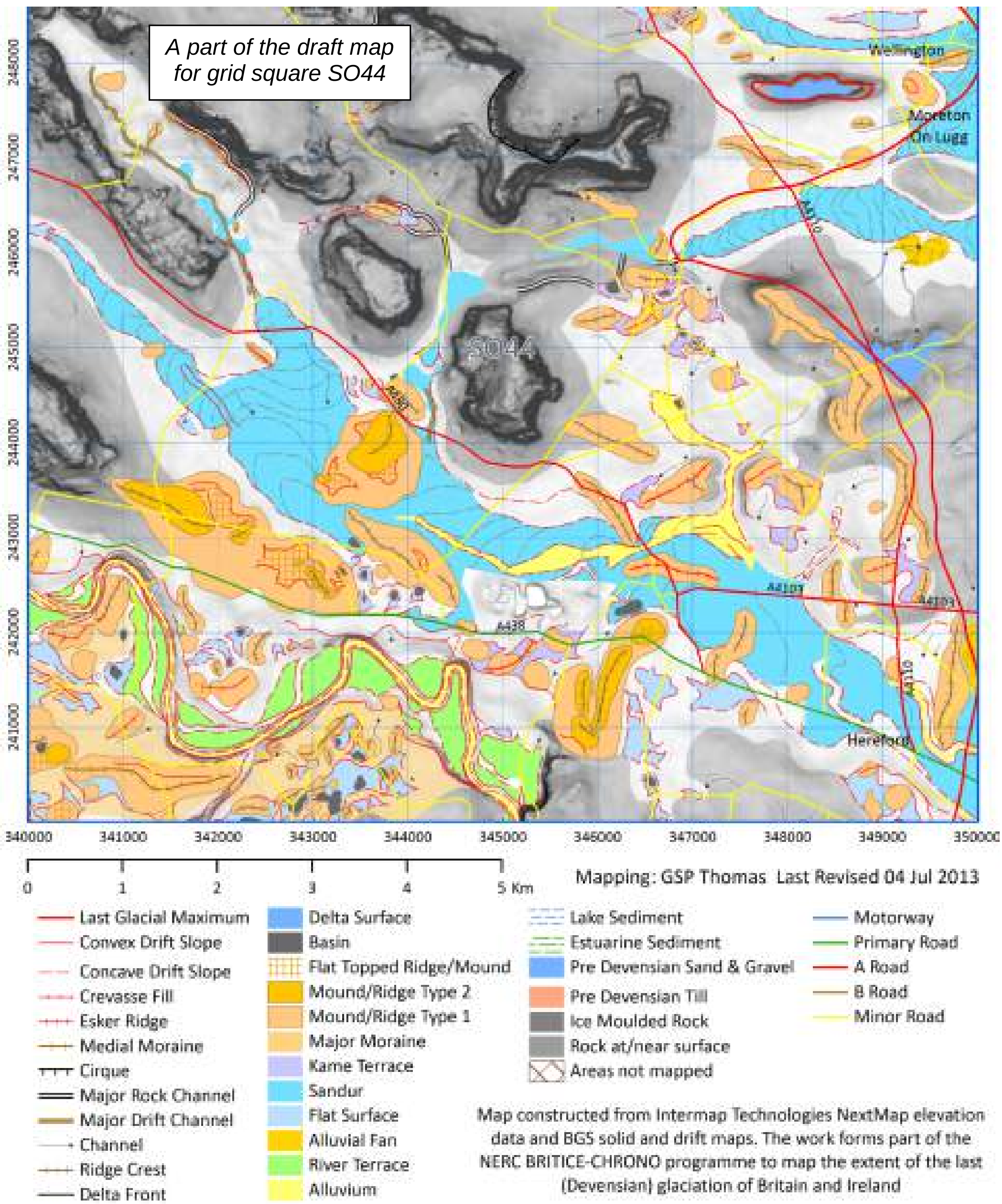
Traditionally, geomorphological mapping was done using 1:10,000 scale mapping in the field. This is time-consuming and often less than accurate due to the very low angle of view of landforms from the observation point and the consequent perspective problems that arise. New mapping methods are based on remotely sensed data. LIDAR is an airborne laser system that scans the ground surface and creates a digital data matrix of height above OD. The whole of the UK is now covered and is available to researchers from NERC. The work described here was undertaken using a 'bare ground' Digital Terrain Model (DTM) in which trees, buildings and other artificial features are automatically removed. The resolution was 1m vertically and 5m horizontally. The DTM can be imported into a GIS, in this case ESRI ARCGIS, and converted into a contour map, a slope map or a shaded relief map, all of which enhance the subsequent mapping task. The DTM can be underlain by BGS drift maps, OS 1:25,000 maps, etc. for use in checking the underlying geology and identifying errors in the landform mapping as it proceeds. Mapping was undertaken at 1:10,000 scale over an area of some 10,000 square km of the Cheshire-Shropshire lowlands and the adjacent Welsh Borderland as far south as Hereford.

The mapping process used a simple, non-generic map symbol system based wholly on geometric forms (concave and convex breaks of slope, ridges, mounds, basins, channels, flat ground, etc). This gives a raw landform geometry map, in areas of both solid and drift outcrop, which is then interpreted using a set of basic glacial feature types such as moraine ridges, esker ridges, sandur fans, sandur troughs, kettle basins, roches moutonées, fluted bedrock, rock drumlins, etc. The process, however, is not without error. For example, Lidar occasionally fails to remove small forest plantations, which may then be erroneously interpreted by their geometry as a drift mound, or moraine. Errors of interpretation also occur when, for further example, a basin is identified as a kettle hole when, in reality, it is a marl pit! Most errors can be corrected, however, by checking against OS 1:25,000 topographic maps or field survey. An example of the maps is shown opposite.

Local 10km squares mapped (red line shows ice extent)

The mapping, now complete in draft, began as a 'retirement' project designed to enhance earlier conventional mapping of parts of the region by the author in the 1980s. It has now been incorporated into Transect T2 of BRITICE-CHRONO, one of a number of similar transects around the British Isles. Analysis of the mapping has revealed numerous closely spaced former retreat-stage ice-margins, mostly identified by moraines, ice-contact slopes, the inner edge of kame terraces, etc. Each margin provides a 'snapshot' in time of the depositional environment formed at and beyond the margin as it retreated and permits construction of a set of staged palaeo-environmental maps. The occurrence of bedrock outcrop, organic-filled kettle basins or sandur sediment between stages provides opportunity for dating using radiocarbon (^{14}C), thermoluminescence, optically stimulated luminescence and cosmogenic nuclide (^{10}Be) methods and sampling for this is currently underway. Ultimately, the geomorphological work described here, together with sedimentological interpretation from outcrop, borehole analysis and dating will reveal a detailed understanding of how our landscape was formed over the last glacial episode.

Evans, D.J.A. and Clark, C.D. and Mitchell, W.A. (2005) 'The last British Ice Sheet: A review of the evidence utilised in the compilation of the Glacial Map of Britain.' Earth-Science Reviews, 70 (3-4), pp.253-312.



GEOLOGY, ARCHAEOLOGY AND RAVENSCAR

Charles and Jean Hopkinson

A WALK during a holiday last year at Robin Hood's Bay on the Yorkshire coast led us to Ravenscar, to the Peak Fault and the remains of an alum works. Knowing little about alum and wondering what could be the relationship, if any, between the local geology and a now defunct industry we decided to investigate….

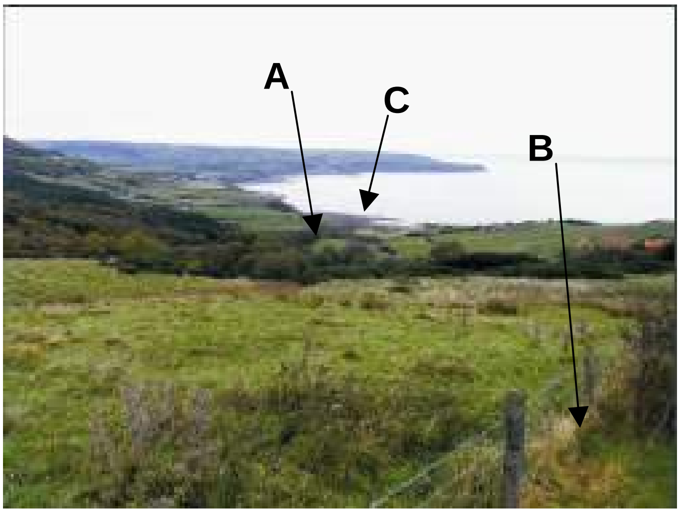


Fig. 1: Robin Hood's Bay at near high tide from the south. The bay is an eroded shallow dome of which the impressive curved 'scaurs' or reefs (Lias Group, [Lower Jurassic]) extending into the bay and visible at low tide are the remains. 'A' marks the position of the old alum works with its quarries just outside the picture to the left. 'B' marks the approximate line of the Peak Fault with the exposure (Figs. 3 & 4) just over the skyline. 'C' marks the scaurs.

Alum has now a large number of industrial uses ranging from the paper industry to the manufacture of Epsom Salts, but until the 19th century—from Roman times and before—its use was more limited, principally as a mordant to fix dyes in textiles, particularly wool, and as a preservative of leather.

Until the 16th century alum had been imported into Great Britain with seemingly no native production, but because of Henry VIII's break with the papacy in the 1530s the pope, who effectively controlled the trade, placed an embargo on exports to Britain; British manufactured textiles had to be sent to the Continent for processing. However, within eighty years or so alum-bearing rocks had been identified along the Yorkshire coast and certainly by 1650 a works had been established at Ravenscar (OS Ref: NZ973021). Ravenscar expanded into a major industrial complex at one time employing 150-200 men and has been judged to have been one of the first, if not the first, chemical works in the country.

In the mid-19th century aniline dyes, which did not need a separate mordant and were the by-products of gasworks, began to replace natural dyes such as saffron and damson; this development, together with the introduction of synthetic methods of producing alum, rendered a 200-year-old industry in Britain redundant and the works at Ravenscar were abandoned in the 1860s.

The Ravenscar alum works owed its existence to geology and for its commercial success to its proximity to the coast. Until the 19th century, transport in this part of Yorkshire was laborious and for heavy industrial products impracticable. Although there was no harbour for the works, small boats could in fine weather run up at high tide under the cliffs and, by way of winches and a rack-railway, discharge or take on board their cargoes of raw materials and finished products. The shale was quarried from the hillside about a third of a mile from the works which was sited below the quarries — thus making use of gravity — on a stretch of relatively level ground between the hillside and the coastal cliffs. Although there is a stream in a deep, steep valley close to the works there is no evidence of a watermill being used. Before the introduction of steam-power a millstone, along with other mechanical processes on the site, must have been driven by animals and the work force.

Fig.2: View inland across the remains of the alum works towards old quarrying of the Lias shales (Lower Jurassic).

Detailed analyses of the geology of the Yorkshire coast around and to the north of Ravenscar can be found elsewhere (BGS Sheet 35 & 44 'Whitby and Scalby', websites, etc). Briefly, the coastal rocks are of the Lower Jurassic Lias Group whilst the higher cliffs are of the Middle Jurassic Ravenscar Group. The alum-bearing

Lower Jurassic shales at Ravenscar and at other sites along the coast contain ingredients needed for the production of alum—aluminium silicate, sulphur in the form of iron pyrites and carbon. Under Old Peak, the headland half a mile or so to the east of the alum works, the shales can be found at sea level at the foot of high cliffs and therefore impractical to quarry. They can, however, also be found on the hillside to the west above the works at about 450 feet above sea level where they can be easily accessed. This disjunction is a consequence of a geological fault known as the Peak Fault about a third of a mile to the east of the alum works.

Figs. 3 and 4: Exposure of the Peak Fault. View inland with to east (Fig. 3) rocks, largely sandstones, of the Ravenscar Group (Middle Jurassic) and to the west (Fig. 4) rocks of the Lias Group (Lower Jurassic).

Movement on the Peak Fault has been the source of some geological speculation, but it is now thought to have been a gradual process, as opposed to a sudden event, over a long period in the Jurassic resulting in vertical and some horizontal displacement with the downthrow on the eastern side. The fault has been traced out into the North Sea and between it and another fault to the south the seabed has sunk to form the Peak Trough. The Peak Fault is impressively exposed in a gully close to the cliffs and at low tide in the rocks below the cliffs; we could see no evidence of it inland of the gully. All signs along the footpath which leads to the exposure of the fault and encourage visitors have been removed for health and safety reasons—in slippery conditions with good reason, as we found out.

The production of alum [potassium aluminium sulphate: $KAl(SO_4)_2 \cdot 12H_2O$] for use as a mordant, was a lengthy, complex and therefore expensive process. It began with quarried shale—about 100 tons of shale would have produced one ton of alum—being stacked in clamps up to 60 feet high in layers between, or in a mass on top of, brushwood fires which were left to smoulder for nine months or more. Other materials which were required were coal and water, with seaweed for potassium and human urine for ammonia. Coal was imported by sea. Supplying the works with seaweed, which was obtained from local foreshores and as far away as the Orkneys, constituted a minor industry in itself; 20 tons of kelp were needed to produce one ton of ash. Huge amounts of urine were locally sourced and also imported by sea from urban communities as far away as London and Newcastle. This was unloaded in barrels from boats docking under the cliffs below the works. According to one authority: “It was widely believed that the best urine was from labouring people who took little strong drink”, and the staler the better as the ammonia was then more concentrated. (Urine has over the ages had a number of uses. For instance, a 15th-century French text about the pelleting of gunpowder, which when transported only too easily separated into its constituents and was unusable, recommended the use of vinegar for the process; but if this was not available then the urine of a ‘wine-drinking man’ would suffice. Urine is an effective fire suppressant and in the days of wooden warships barrels of it would be stacked on deck before going into action).

As an example of 17th- and 18th-century technology, “The gravity of the alum liquor was measured by dropping a hen’s egg into the mixture to see if it floated. This would ensure the correct concentration of the liquor was achieved to allow alum crystals to form without sulphate forming too” (Information from National Trust). Finally the alum ‘flour’ would be shipped to London and other sites in Britain and the Continent. Such was the value of alum that a cannon found at Ravenscar and now on display was probably one of the defensive measures taken to protect the site in wartime and against piracy.

The site of the alum works and the exposure of the Peak Fault, together with stretches of the coast along Robin Hood’s Bay, are owned by the National Trust which we understand has plans in the not too distant future to open up the two sites at Ravenscar still further. This would be well worthwhile for they are examples of an interesting relationship between geology and industrial archaeology.

USING GEOPHYSICS TO EXPLORE FOR HYDROCARBONS

Dr John Donato
Merlin Energy Resources Limited

I BLAME MY FATHER! He was the talks organiser for the Peterborough Probus Group and he was short of speakers. My arm was gently twisted. I put together a series of slides attempting to describe the geophysical aspects of hydrocarbon exploration. A few years later he cornered me again, this time for the Malvern Probus Group. Coincidentally, during the same week I repeated the talk for the Geology Section of the Woolhope Naturalists' Field Club. Subsequently I was asked to submit a brief summary of the talk - this is it!

Although exploration geophysics includes a wide range of differing techniques, the search for oil and gas hinges mainly upon the seismic method. In principle this is very straightforward (Figure 1). A loud source sends sound waves into the sub-surface and reflections (echoes) are recorded back on the surface using an array of sensitive receivers.

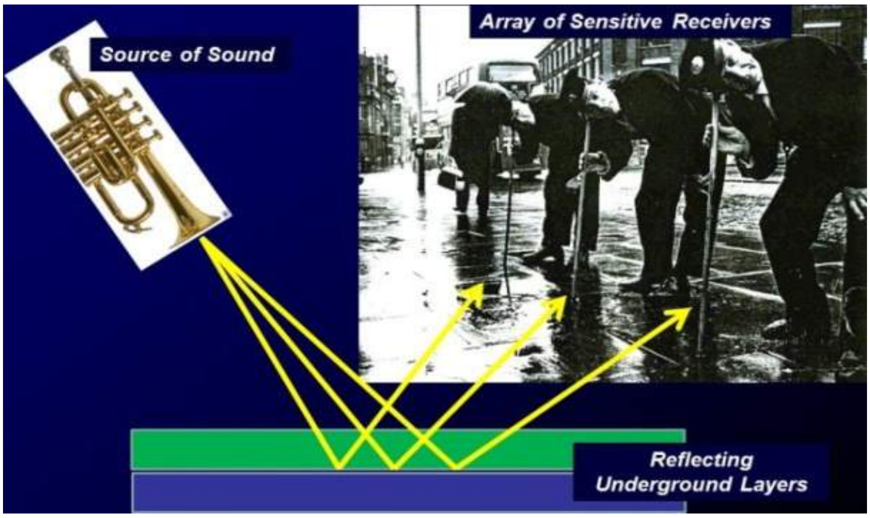


Figure 1 - The basic principles of the seismic method

These reflections are computer processed to produce cross-section images of the underground geological structure. Geophysicists and geologists then try to interpret these cross-sections. Having completed an interpretation, the team will decide if any prospects merit recommendation for exploration drilling. If management approval is obtained, the maps, ideas and interpretation are put to the test by exploration drilling, usually a very expensive exercise. Frequently, the well will be a dry hole and will not find any hydrocarbons. Then the exploration team will need to make their excuses! If, however, the well is successful, there are usually many who appear from the woodwork to lay claim to the credit!

Starting with the seismic data acquisition, the first requirement is to make a loud noise to penetrate into the subsurface. This sound source, or 'shot', may be produced in numerous ways. For example, onshore a shallow hole charged with dynamite can be fired. Also onshore, a continuous sweep of energy can be sent into the sub-surface from metal plates in contact with the ground and mounted beneath heavy vibrating trucks (Vibroseis)! Offshore, a common method is to tow an array of air guns a few meters deep within the seawater. Air under high pressure (2,000 to 3,000 psi) is simultaneously vented from the gun array producing the 'shot'. Guns with different volumes are included within the array so that the waveform may be tuned to produce the required sound-pulse characteristics. For both onshore and offshore, the normal distance between successive 'shots' is of the order of 25m to 50m.

Having sent the sound waves into the ground, significant buried geological boundaries (e.g. the top of a hard limestone unit within a shale sequence) will produce reflections that propagate back up to the surface. A line or areal array of sensitive receivers is laid on the ground (or towed behind the seismic vessel) to await these returning weak reflections. In an onshore environment, the receivers are instruments called geophones. These are pushed into the ground using attached spikes and produce a signal that is highly sensitive to ground motion. Many thousands of these are used and are grouped together in lines, typically up to 6 or 7 km in length, or over a rectangular area of several square kilometres. In an offshore environment, the receivers are located within long streamers, many kilometres in length, towed behind the vessel. These receivers are normally hydrophones, sensitive to changes of pressure in the seawater. The received reflections will normally have a total (two-way) travel time from source and back to receiver of up to 4 secs, representing depths of between 6 and 8 km.

Figure 2 – One method of producing the seismic 'shot'. Here a weight-drop device (Thumper) is employed across a golf course on the Isle of Wight. No 'shots' were acquired from the greens!

Figure 3 – A recording truck running an onshore survey in Romania. The inset (top right) shows a single shot monitor record.

The onshore seismic acquisition operation is controlled from a central point housed within a recording truck (Fig 3) or within the seismic vessel for the offshore situation. Each time a shot is fired, monitor records are displayed (Fig 3 inset) showing the signals recorded on each of the groups of receivers along the recording array. In this way the observer can review the quality of the data being acquired. Background noise is often a serious problem, e.g. wind and wave interference offshore. Frequently, recording will be stopped to await less noisy conditions. The data are recorded onto computer tapes and/or disk drives and these are sent to processing centres. Processing of the data is complex and time consuming. It involves analysing the thousands of records from the receiver arrays.

Eventually, usually several months after acquisition, the final processed seismic sections are produced, and detailed interpretation can begin. Figure 4 shows an example seismic line (courtesy of BGS). Black and white lines on the seismic section denote reflecting interfaces within the subsurface. On this section, the interpreter has marked the locations of faults and three important geological interfaces are shown in colour. These are significant surfaces for which structure maps will be prepared. The maps will firstly be contoured in two-way-travel time. Subsequently, these time surfaces will be converted to depth, frequently a difficult process as velocities can vary significantly both vertically and laterally.

The seismic data can often provide other important information, in addition to the geological structure. For example, reservoir porosity can sometimes be determined and, on rare occasions, fluid content (gas or oil) may be inferred, but this is never infallible! The detailed geometry of the reflectors may provide information on the timing of structural development and associated fault movement. This may be compared to time estimates for hydrocarbon generation and migration.

Shown in Figure 4 are the locations of five notional well locations along the seismic line. These have been positioned to explore five hydrocarbon prospects; 'Alice', 'Betty', 'Christine', 'Doris' and 'Emily'. The locations are designed to test a range of possible hydrocarbon traps involving anticlinal structures, tilted fault blocks and stratigraphic pinch-outs. It is not possible to describe the details here, but during the talk the geology of the basin was described briefly and layers of likely reservoir and source rocks highlighted. Members of the audience were then invited to 'invest' in the prospect of their choice. One by one, the prospects were 'drilled' to the depths shown by the vertical yellow lines and the likely outcomes explained. Four of the locations are dry holes but at the position of the ‘Alice’ exploration well is an actual oil field. Here, a porous sand reservoir is located beneath a sealing shale and is connected to an oil migration pathway. This has resulted in a commercial hydrocarbon accumulation. Strangely enough, at the Malvern Probus talk several of the audience were successful in discovering the oil field but at the Woolhope Geology Group meeting no one was successful!

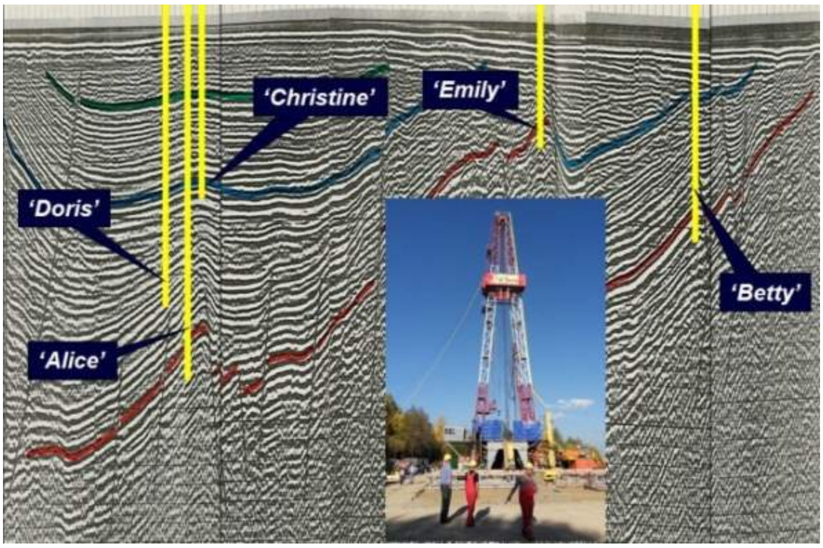


Figure 4 - An example seismic section. The vertical axis represents the two-way travel time (~0 secs (seabed) at the top and 3 secs at the base). The horizontal axis shows the distance along the line (approximately 60 km from end to end). The vertical yellow lines show the locations of five notional exploration wells ‘drilled’ by the Woolhope Group!

It is a long, interesting and exciting journey from planting the first geophone in the ground to seeing the results obtained by exploration drilling. Of course, if the well is lucky enough to be successful, then another long journey begins, involving economic evaluations, further seismic acquisition, reservoir simulations, appraisal drilling and a possible field development.

Meeting Reports

by Dr Geoff Steel

Friday 16th November 2012 : Listening for Oil

Dr John Donato is a geophysicist at Merlin Energy in Ledbury. During the forty years of his career he has seen the rise of oil and gas exploration in the North Sea to a peak in the 1990s and now a gradual decline. In this talk he described the seismic survey techniques which are used, and the methods for analysing the data.

For surveying on land a 'Vibroseis Truck' is used. It is jacked up onto a metal plate and driven with a high-intensity vibration. Many thousands of geophones are strung out on cables to record the echoes. For surveying at sea an explosive or, more commonly, a set of air guns are used and thousands of hydrophones are towed on cables behind the ship.

John showed five examples of real seismic data taken in the Moray Firth. He described the source rocks (organic shales) and reservoirs (sandstones) which can be identified from known exposures on land. One was a true find – the Beatrice Field. It cost £400m to develop, has produced £400m in profit, and has generated £500m in tax revenue.

(This talk is fully described in the article on page 10.)

Friday 7th December 2012 : Members' Evening

For the first part of the evening we looked at exhibits brought in by members. These included photos from the Pembrokeshire trip in September, one of them made into a painting. Moira Jenkins brought an unusual sample of crystalline Wenlock limestone from Colwall. Brian Betts showed pictures of Mount Etna in 1951. Chris Fletcher showed galena, fluorite and barytes from Derbyshire and described how calcite was quarried there recently to face the Humber Bridge. Rosamund Skelton showed a sample of tuff from Builth Wells with chlorite and albite crystals formed by metamorphism of mafic minerals. Following the exhibits Sue Hay gave a talk about Sicily with photos of the places she visited. And Geoff Steel described some mica samples with photos of their sources in Scotland.

The Members' Evening

Friday 1st February 2013 : 'The Road from Damascus to the Seven Pillars of Wisdom'

This talk by Sue Hay was postponed from January due to the snow. The Levant is geologically very active. It sits at the boundary between the African, Eurasian, Sinai and Arabian plates with the Dead Sea Fault aligned north-south. The talk followed a journey from Damascus in Syria to Jordan's Red Sea coast looking at the geology and building stones. This included historic sites such as Palmyra and Petra and the stunning landscapes of the Dead Sea and Waddi Rum. The sparse vegetation leads to good geological exposure dominated by extensive outcrops of Mesozoic and early Tertiary sedimentary rocks, mainly carbonates, which were deposited in the southern shallows of the Tethys ocean between Europe and Africa. Overall, rock ages increased in a southerly direction with the Precambrian exposed around Aqaba.

Stone has been used and reused in the region since Neolithic times. This was probably shown best at the Umayyad Mosque in Damascus, a world heritage site. It stands on what has been considered sacred ground for at least 3000 years. A basalt orthostat from an Amamean temple built in 1000BC, depicting a sphinx, has been discovered in the northeast corner of the mosque. Roman and Christian buildings stood here before the mosque, whose current prayer hall roof is supported by Roman Pillars from the Temple of Jupiter.

Friday 22nd February 2013 : AGM and Dinner

Our Chairman, Gerry Calderbank, was unable to attend due to illness so Geoff Steel, the Vice Chairman, ran the meeting. Minutes of the last AGM were read and then Paul Olver, the Secretary, gave an update on recent developments. All chapters of our book on Herefordshire geology are now written but we still await some photos; publication is expected next year. Another trench has been dug at Martley and the research group has prepared a paper for the transactions. In her Treasurer's report Beryl Harding confirmed that our bank balance is still healthy, with sales of the DVD "Picnic in Siluria" still continuing. Moira Jenkins told us about her recording of sites at Huntsham, Colwall, Symond's Yat and Garren Brook, and asked that we let her know of any new exposures. Sue Hay gave an update on work in the Geopark, including rock & fossil roadshows and two installations of earthquake monitoring centres, and also at the Earth Heritage Trust, where a study of building stones is underway. Geoff Steel was elected as the new Chairman. Vice Chairman is Gerry Calderbank (although absent he had already volunteered). Sarah Skelton has offered to replace Kate Andrew as our Heritage Services representative. The remainder of the committee was re-elected for another year with Tony Geeson also joining.

As always we held our Annual Dinner after the AGM. Following some evenings of 'research' Sue Hay recommended the Merton Hotel where the meal proved relaxed and enjoyable.

Thursday 7th March 2013 : Snowball Earth

Dr Gawan Jenkin of Leicester University gave this talk to a joint meeting with Hereford Astronomical Society. He described how Neoproterozoic tillites of apparently glacial origin were mapped during the last century, but their association with warm-water limestones was puzzling. In some cases palaeomagnetic studies added further mystery by revealing latitudes close to the equator.

In 1992 Joe Kirschvink coined the phrase 'Snowball Earth' to summarise his belief that glaciers did indeed extend to the equator. The idea was controversial because a high albedo would keep the Earth frozen for ever. How could it end? Recent research has suggested an answer: carbon dioxide from volcanoes built up in the atmosphere causing an extreme greenhouse effect which could melt the ice in just a few thousand years. Dr Jenkin has studied the resulting warm-water limestones in Ethiopia and Australia. These so-called 'cap carbonates' formed when huge amounts of carbon dioxide suddenly dissolved in the newly ice-free oceans.

But what started the freezing? Detailed dating shows three separate glacial events: Sturtian, Marinoan and Gaskiers at approximately 710, 650 and 580 Ma respectively. The first two of these correspond to the break up of Rodinia into several smaller continents. Fresh basalt (from rifting) weathers easily and removes carbon dioxide. And the third event corresponds to the appearance of multi-cellular life. Were these connected? As scientists always say, “More research is needed!”

Friday 22nd March 2013 : Geological Quiz

Due to poor weather, Bill Fitches’s planned talk had to be postponed. At short notice, Sue Hay provided us with an entertaining geological quiz whereby she laid out twenty-six items, rocks, fossils, minerals, pictures and maps. The aim was to identify each item, or an important feature of it, with a letter of the alphabet, all the items being represented by a different letter. This proved to be challenging, entertaining and very successful.

Sunday 21st April 2013 : Para-, Peri- or just Plain Glacial?

Nine members met at Craig y Cilau on a cold and windy Llangatwg escarpment. This is an impressive Carboniferous Limestone feature with very interesting Ice Age landforms. Duncan Hawley, our leader, took us on a 7km walk and got us to pick out the geomorphological forms. These included the limestone cliff with screes, a raised bog, and a large ridge about 300m from the embayed cliff with a well cut valley between, and hummocky terrain on the ridge. Eventually we reached a minor embayment in the cliff and screes; a narrow ridge extended across the front of this, with a hollow behind with many limestone boulders. The origin of this ridge was discussed, particularly whether it was a pronival rampart.

At this point Duncan revealed to us the current thinking on the origin of this landscape. The sequence of events consisted of an early glaciation in the area of the bog and an ice tongue in the valley under the cliff. Water from this lubricated the rocks (sandstones and shales) underlying the escarpment. Melting away of the ice tongue removed support for the escarpment and initiated a major rotational landslip, the lower parts of which now form the large ridge. A later and smaller glaciation led to a moraine forming near the bog. A further smaller landslip formed the small embayment with its fronting ridge. This was an altogether fascinating excursion and the area is well worth a visit by those who missed it.

The escarpment of Craig y Cilau with the raised bog in the foreground and the landslip ridge to the left.

Sunday 16th June 2013 : The Ercall and the Wrekin

Nine WGS members and two visitors met Andrew Jenkinson of the Shropshire Geological Society at the Forest Glen car park. Andrew explained something of his views on helping the public to understand geology and then showed us interesting details of the centre part of the quarry face; a dolerite dyke, a surface of mylonite with slikensides, and a breccia of crushed rhyolite.

The Precambrian/Cambrian unconformity in Ercall quarry.

Ercall quarry, about a kilometre away, shows a splendid and obvious unconformity between Precambrian granophyre and the Wrekin Quartzite at the base of the Cambrian. We climbed up for a close inspection. At the base of the quartzite is a breccia containing clasts of apparently kaolinised granophyre. Close by, an exposed bedding plane in the quartzite showed a fine array of ripple marks and at the end of the quarry we saw the boundary with the overlying Comley Sandstone. A further walk took us to Maddocks Hill quarry, worked for aggregate (camptonite) in the 1970s and which removed almost the entire hill. We searched successfully for graptolites on the rock face and debris of a partly baked Shineton Shale exposure. It was the discovery of graptolites in these and other strata that triggered a redefinition of the Cambrian/Ordovician stratigraphy in the 1990s.

After lunch Andrew led us up to the summit of the Wrekin. The rock exposures are mainly in the track and are nicely polished by the feet of walkers. We saw good examples of the quartzite and rhyolite which form the bulk of the hill. At the top Andrew pointed out and explained the numerous topographical and geological features of the area, notably the Long Mynd and the Ironbridge Gorge.

Flow-banded rhyolite on the Wrekin.

Sunday 21st July 2013 : The Lickey Hills

Julie Schroder and Jill Harvey (members of the Community Earth Heritage Champions Project) were our guides for the day. Julie explained that the main ridge of the Lickey Hills is an anticline of hard quartzite and is the most easterly exposure of Ordovician rocks in England.

Starting at Warren Lane Quarry we saw the steeply dipping western limb of the anticline. Above the quarry we walked to the top of Bilberry Hill, the centre of the anticline, where there is an outcrop of a strange brecciated quartzite. From there a steep path led down to Barnt Green Road Quarry. This was studied by Charles Lapworth in the 1890s but subsequently became overgrown. Three years ago the Champions organised a huge cleanup operation. They have revealed a classic section through an overturned fold on the eastern limb of the anticline. Sue Hay described her work on some thin sections from here which showed that dark grains in the quartzite have an igneous origin.

After lunch we headed westwards onto newer rocks: firstly red shale (the Keele Beds) then up onto Beacon Hill which is formed of Clent Breccia. A path over the Bunter Pebble Beds led back to the start.

Finally we drove to the A38 road cutting at Rubery. Here we could see an unconformity between the Lickey Quartzite and the overlying Silurian sandstone. The Champions have also cleared this cutting; their hard work has been very valuable and we thanked them for a superb day with fine summer weather.

Sunday 18th August 2013 : Westonhill Wood

On a pleasant summer's day, seven members joined Duncan Hawley, Bill Barclay (ex-BGS) and the owner, Graham Kirk, for a geological exploration of a recently opened section in the lower Old Red Sandstone. The exposure, in the side of a quarry track on the north side of Merbach Hill, near Bredwardine, is nearly continuous for almost 1km. The Raglan Mudstone Formation outcrops in large parts of Herefordshire but is seldom clearly seen because of its fragile nature. On this visit, though, many features were visible and included heavily bioturbated parts in which the remains of small burrows were found, an intraformational conglomerate deposit as a channel fill and a variety of immature calcrete layers, some displaying excellent examples of pseudoanticlines (see picture on page 1). The upper four of these calcrete layers were thought to represent the Bishop's Frome Limestone. Above the Limestone lies the better known St Maughans Formation. This consists mainly of sandstones, which are the subject of Graham's quarrying activity higher on the hill. The trace fossil *Beaconites Antarcticus* (a filled-in burrow about 10cm in diameter) was found on a block in this higher quarry. Near the top of the hill the sandstone was seen as thinly laminated tilestones .

Beaconites Antarcticus in the St Maughans sandstone.

Saturday 21st September 2013 :
Landscape and Geology of Rudry, Caerphilly

Three members braved the mist and low cloud to spend a fascinating day with Tom Sharpe, from the National Museum of Wales, looking at the south-eastern margin of the South Wales coalfield. Although the exposure is poor it was sufficient to gain an understanding of the relationship between the underlying geology and the landscape. Initially we walked down the sequence from the Pennant Sandstone to the Devonian Brownstones before climbing back up again past evidence of ironstone and lead being mined in the area. After lunch the skies cleared so that we had good views across the Severn estuary to north Somerset and northwards to the Brecon Beacons.

GEOLOGY SECTION PROGRAMME FOR EARLY 2014

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

Friday 24th January.

'Structural mapping and interpretation of a complex unconventional gas discovery'.

Talk given by Dr Tim Wright and Sarah Pearce, Consultant Geoscientists at Merlin Energy, Ledbury.

Friday February 28th.

Section AGM followed by the Section Dinner. Booking forms for the dinner will be sent out electronically in January.

Friday 21st March.

'Eyjafjallajökull 2010: Aerial Geohazards'.

Talk by Sue Hay and Gerry Calderbank.

Sunday 13th April.

Field trip to the Penarth area, led by Tom Sharpe, National Museum of Wales.

Further information for all events, unless otherwise stated, from: Sue Hay, 01432-357138 or e-mail svh.gabbros@ btinternet.com.

EDITOR'S NOTE

WELCOME to the tenth issue of Earth Matters. It contains the usual regular reports, of our own activities and those of the Earth Heritage Trust, Geopark and the Museum Service. In addition we have a summary of one of our lectures, two items stemming from the 'Wye Valley' project of the Earth Heritage Trust, a holiday report from Yorkshire, a description of the national BRITICE project which has generated valuable local information, and a poem. I would like to thank all the contributors for sending their articles to me by the deadline and within the prescribed word count.

We have no article this year about the Section's important research work at Martley in collaboration with EHT, the Teme Valley Geological Society and under the scientific lead of Bill Barclay (ex-BGS). Readers will find a full account of the work up to the summer of 2012 in the current issue of the Club Transactions (albeit with a few unfortunate errors). A further paper detailing subsequent work and discoveries will appear in the Proceedings of the Geologists' Association.

Further, we await with keen anticipation the publication of the Woolhope Club's new book on Herefordshire geology, produced under the editorship of Paul Olver and Peter Oliver of EHT.

For reasons of cost we keep to a minimum the number of printed copies of Earth Matters. As we supply a copy of the current issue to new members of WGS joining through the year, we are in constant danger of running short. Please might I therefore appeal to those who read EM and then dispose of it, instead to return copies, if in good condition, to myself or Beryl.

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 28th February 2014** starting at 6:00pm in the Woolhope Room. After the AGM we will retire for dinner to a local 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. Section members are invited to submit nominations for election to the committee. Nominations, with the names of the proposer and a seconder, must be received by the Section Secretary in writing (letter or email) before 28th January 2014.

WALK IN SUPPORT OF GEOFEST 2014

MEMBERS will be pleased to learn that Sue and Moira have raised £400 from the Section's sponsored walk on 20th October in aid of Geofest 2014. Many thanks to all who contributed.

HOW FAR CAN YOU SEE?

THE QUESTION sometimes arises whether a particular locality can be seen from a distance, usually from a viewpoint. Much-visited viewpoints are often provided with toposcopes showing the surrounding panorama and intended to answer such questions. A number of web sites exist which should give definitive answers concerning such lines of sight. Three such sites are

https://www.heywhatsthat.com/profiler.html
www.udeuschle.selfhost.pro/panoramas/makepanoramas_en.htm
https://www.viewfinderpanoramas.org

All take account of refraction in the atmosphere and the Earth's curvature. The first one generates a height profile along the desired path while the others deliver detailed panoramas from the chosen viewpoint. They show, for example, that from the Worcestershire Beacon the furthest potentially visible ground is Shining Tor in the Peak District, 130.5km away. As the path to this lies across the Black Country it is probably always obscured by poor atmospheric conditions. An article which provides further information is 'Can the Malvern Hills be seen from Dunkery Beacon', Proceedings of the Cotteswold Naturalists' Field Club, vol.45, pp.304-315 (2012).

Members of the WGS Committee (December 2013)

Dr Geoff Steel, ***Chairman***

Gerry Calderbank, ***Vice-Chairman***

Dr Paul Olver, ***Secretary***

Beryl Harding, ***Treasurer***

Dr Sue Hay, ***Programme Secretary***

Moira Jenkins, ***Section Recorder***

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

Charles Hopkinson, ***Minutes Secretary***

Tony Geeson

Sarah Skelton, ***Museum Representative***

H&W Earth Heritage Trust and Abberley & Malvern Hills Geopark

Early 2013 was a time of many changes at the Trust. January saw recruitment for the 'Building Stones' project with Kate Andrew, latterly at Herefordshire Museum and Resource Centre, becoming project manager and two newcomers to the area, Beth Andrews and Elliot Carter taking on the community and technical roles respectively. In March, Liz Elston, for so many years the office manager, moved back into full time Human Resources and Nina Jeniec joined the Trust to run the office along with David Pamment, a volunteer for several years, taking on the Trust's finance.

The Building Stones project is now making headway in recruiting interested volunteers and is starting to run training courses. Kate will be talking about the project at the Woolhope meeting on Saturday 11th January. If you are interested in finding out more look at the Trust website or contact Beth on 01905 542014.

The Trust still needs another project to cover all the overheads but unfortunately all Nina's hard work on a new project in Herefordshire aimed at the younger generations was turned down by Heritage Lottery. But the Trust still has hopes of finding a funder for this.

Michael Brooks, an IT expert, has started producing apps on the Geopark Way. They can be purchased from the Apple store and Google. About 2/3 of their cost will go to the Trust.

Behind all this activity, the trustees have been working on producing a strategy to get the Trust back on a more stable financial footing. By the time you read this some actions should be underway but it will take time. Unfortunately our Treasurer, Mike Bath, stood down in August so we are also seeking a new treasurer. Anyone interested should please contact me to discuss the role.

Geofest was opened by the Geopark President, Chris Darmon, in the new Geopark Visitors Centre on the Malvern Hills at the Skott Building just west of the Wyche Cutting. It is well worth a visit. There is a café and a Geopark display on ipads plus good views across the Herefordshire countryside. The centre is open every day except Wednesdays.

Geofest was again a great success with over 11,000 people taking part over the three months. Planning and fund raising for next year's, the tenth, is now underway, including our section walk on October 20th. Many thanks to all who contributed time, effort and finance.

Sue Hay *(H&W EHT Chairman)*

Herefordshire Museums Service

The annual geology open day was held in April in partnership with the Rock and Fossil road show of the Earth Heritage Trust (EHT). This year the theme was Silurian seas so family visitors were making Silurian sea scene dioramas and casting fossils of the type which would have been found in the local area, such as fossil corals. Trilobite races were run through a wiggly course of replica rocks using the remote control trilobites that are the stars of the Rock and Fossil road show. Great fun was had by all despite the slightly erratic steering mechanism on the trilobites!

Late in 2012 the full handwritten catalogue of the fossils held by the Museum, which was carefully compiled by our volunteer fossil expert Tess Ormrod, was transferred onto the Museum database system by Russell Dornan, curatorial trainee for 2011-12. The fossils collection can now be easily searched on the digital database rather than manually. In the future the service hopes to photograph and tag images of each specimen to all of these records to further improve access.

In the past year specimens from the geology collections have appeared in several exhibitions, not least the Alchemy of Stone exhibition by David England. This Worcestershire-based sculptor wanted to include the oldest rocks found in Britain in his exhibition. Happily we have examples of Lewisian Gneiss in the collection so these attractive rocks went on display.

The '100 objects in 100 years' exhibition in the summer of 2012 celebrated the history of Hereford Museum. The geology collections include some very early specimens which were donated to the museum at its inception from the Literary and Philosophical Society.

Sue Knox, the Museum Development Officer for Herefordshire, is on the advisory panel for EHT's '1000 Years of Building with Stone' project. Sue helps in its recruitment of volunteers. This project will be taking place in Hereford city centre, Ross-on-Wye and Kington and will record stone buildings and their quarry sites.

So, despite the uncertain times which the museum service is currently facing, the geology collections continue to be at the heart of the museum's programme of activities.

Sarah Skelton *(Senior Collections and Access Officer)*