# Newsletter No. 275
# October 2022

The Black Country Geological Society
www.bcgs.info

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**Copy date for the next Newsletter is Thursday 1 December**

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**Stone age lunch break – to find our where, read on!**

| **Mark Jeffs**<br>**Honorary Secretary,**<br><br>honsec@bcgs.info | **Andy Harrison,**<br>**Field Secretary,**<br><br>☎ 07973 330706<br><br>fieldsecretary@bcgs.info | **Julie Schroder,**<br>**Newsletter Editor,**<br>42 Billesley Lane, Moseley, Birmingham, B13 9QS.<br>☎ 0121 449 2407<br>newsletter@bcgs.info |
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For enquiries about field and geoconservation meetings please contact the Field Secretary.
To submit items for the Newsletter please contact the Newsletter Editor.
**For all other business and enquiries please contact the Honorary Secretary.**
For more information see our website: bcgs.info, YouTube, Twitter: @BCGeoSoc and Facebook.


# Future Programme

**Indoor meetings are normally held in the Abbey Room at the Dudley Archives, Tipton Road, Dudley, DY1 4SQ, 7.30 for 8.00 o'clock start unless stated otherwise.**

*Visitors are welcome to attend BCGS events but there will be a charge of £1.00.*

**Monday 17 October *(Indoor Meeting):* 'Geology of Iceland and the Fagradalsfjall eruption 2021'.** Speaker: Alan Clewlow (BCGS Treasurer).

**Sunday 6 November *(Geoconservation Day):* Saltwells Local Nature Reserve.** Directed by Reserve Wardens and Friends of Saltwells Nature Reserve. Meet at the Wardens Hut adjacent to the Nature Reserve car park (Grid ref: SJ 934 868) on Saltwells Lane 9.45 for a 10.00 start. Wear old clothes, waterproofs and stout footwear. Please bring gloves and garden tools: hand brushes, trowels, loppers, secateurs, forks and spades if you have them. Either bring a packed lunch, or hot food can be acquired from the Saltwells Inn adjacent to the car park. Finish at 2.30.

**Monday 21 November *(Indoor Meeting):* 'Bilston Stone Quarries - Digging up the Past'.** Speaker: Graham Hickman (President of the GA and member of BCGS). Graham wrote about his family connections to these quarries in December 2010 (Newsletter 204). Combining his genealogical and geological research, this talk will explore the geology where his ancestors dug a living for themselves, alongside the historical documents and evidence they left behind. *More information on our website. Ed.*

**Saturday 10 December *(Geoconservation Day):* Portway Hill, Rowley.** In collaboration with the Friends of Rowley Hills and the B&BC Wildlife Trust. Meet at St Brades Close (just off Tower Road) at 9.45 for 10.00 (Grid ref: SO 974 893), nearest PC: B69 1NH. Directions: from Birmingham New Road (A4123) turn left on to Tower Road if coming from Birmingham, right if coming from Wolverhampton. Just after Bury Hill park, turn left onto St Brades Close. Wear old clothes, waterproofs and stout footwear, and bring gloves. Tools are provided but feel free to bring your own. Also bring a packed lunch. Hot drinks provided. Finish at 1.30.

**Monday 12 December *(Indoor Meeting, 7.00 for 7.30 start):* Members' Evening and Christmas Social.** This is our annual chance for members to share their geological experiences in a sociable atmosphere with a Christmas buffet provided by the Society.

***Contributions needed from you!***

We need a few of you to volunteer to do a short presentation - on any topic with geological connections; or perhaps bring some of your specimens for admiration, discussion and identification. Please contact Mark Jeffs if you can contribute to this event: honsec@bcgs.info

**Monday 16 January 2023 *(Indoor Meeting):* 'Jurassic Gems of the Yorkshire Coast'. Speaker: Liam Herringshaw.**

**Monday 20 February *(Indoor Meeting):* 'Glacial Boulders at Wightwick Manor, Wolverhampton'. Speaker: Clive Roberts.**

**Monday 20 March *(Indoor Meeting):* 'Celebrating the Origins of Animal Life: Building a UNESCO Global Geopark in Charnwood Forest, UK'. Speaker: Jack Matthews** (Geoheritage Conservation and Interpretation Officer for the Charnwood Forest Geopark, UK). Charnwood Forest in Leicestershire is host to some of the oldest animal fossils in the world. This presentation will outline the internationally significant geodiversity of Charnwood Forest - including the outstanding ancient fossils - and the ways it has shaped the landscape, communities, and people of Britain's 'unexpected upland'.

# Other Societies and Events

## Woolhope Naturalists' Field Club - Geology Section

**Saturday 15 October: 'Herefordshire Lagerstette: soft-bodied fossils from Silurian volcanic ash'.** Speaker: Prof. David J. Siveter, Emeritus Professor of Palaeontology, University of Leicester.

**Friday 18 November: 'Tectonics and landscape evolution'.** Speaker: Professor Tony Watts, Marine Geology & Geophysics, University of Oxford.

Non-members of the Club pay £2. Visit: https://www.woolhopeclub.org.uk/meetings All meetings will be held in Hereford Town Hall. Friday evening meetings start at 6.00, Saturday afternoon meetings at 2.00 unless otherwise notified. Non members are welcome.

## Shropshire Geological Society

**Wednesday 9 November: Redrawing the Geological Map of South Wales.** Guest speaker: John Cope, National Museum of Wales.

Lectures are being held using Zoom and commence at 7.15 for 7.30. Further info: http://www.shropshiregeology.org.uk/SGS/SGSEvents.htm

## Teme Valley Geological Society

**Monday 24 October 7.30: 'Reefs and Microbiolites'.** Speaker: Stephen Kershaw, Brunel University.

**Monday 28 November 7.30: 'Old Red Sandstone rivers and floodplains: processes, palaeosols and trace fossils'.** Speaker: Dr Susan Marriott, Bristol University.

Non-members £3. For field trip details and further information contact John Nicklin, email: martleypfo@gmail.com or phone on 01886 888318 or visit: https://geo-village.eu/

## Warwickshire Geological Conservation Group

**Thursday 17 November: 'The Moine Thrust Controversy'**. Speaker: Peter Gutteridge.

There is a charge of £2.00 for non-members. This meeting is both live at St Francis, Leamington and by Zoom. For more details visit: http://www.wgcg.co.uk/ or email: WarwickshireGCG@gmail.com.

## Manchester Geological Association

**Saturday 19 November at 1.30: The Broadhurst Memorial Lectures - Spectacular British Fossils**
**Unearthing the 'Rutland Sea Dragon' - A Jurassic Giant in the UK.** Speaker: Dr Dean Lomax.
**On the exquisite pterosaur material from the Scottish Hebrides /or/ Why pterosaurs generally suck.** Speaker: Natalia Jagielska. (Additional speaker tbc.)

**Saturday 10 December at 1.30: Geology in Industry.**
**'The UK's nuclear legacy - opportunities and challenges'.** Speaker: Prof. Katherine Morris.
**'Biosteering the world's oldest and deepest reservoirs'.** Speaker: Wyn Hughes.
Short talks by 2-3 recent graduates on their experience in industry.

Events are likely to take place via Zoom. Visitors are always welcome. For more information: http://www.mangeolassoc.org.uk/ or contact lectures@mangeolassoc.org.uk

## Lapworth Lectures

**Tuesday 8 November:** Details TBC

**Tuesday 29 November:** Details TBC

**Monday 12 December: 'Dinosaurs, Middle Earth, and the Invention of the Deep Past.'** Dr Will Tattersdill, Senior Lecturer in Popular Literature, Liberal Arts, and Natural Sciences, University of Birmingham.

Please keep checking the Lapworth Museum's website for details: Lapworth Lectures & Events

# Editorial

This issue is belated for the best of reasons - we were away on the BCGS field visit to the Dingle Peninsula when we might otherwise have been working on the Newsletter. There will be a full report of this fantastic action-packed trip in the December issue. It turns out that this month has provided us with a bumper post-bag of articles, reports and items of interest from many sources.

We have meaty field reports from Andy (Barr Beacon) and Ray (The Stiperstones) plus the usual Erratics project up-date, Matt's Maps, and another treat from Mike Allen - this time musing on the subject of metamorphic rocks. I'm pleased to include another short item from long-term member Mike Williams, following from his previous contribution in the June issue - both items connected by the theme of Murchison. Finally we bring news of Roy Starkey's latest book, a biography of Sir Arthur Russell, (p.21).

Please note in our programme that we need contributions for the Members' Evening on 12 December. Please contact Mark Jeffs as soon as possible if you feel you could do a short presentation on something geological which has inspired you.

I would like to take this opportunity to thank Alan Clewlow for standing in as Meetings Secretary for the last few months in order to provide a programme of meetings for us all to enjoy. This is a temporary arrangement as Alan also gives his time as our Treasurer, so this is a good time to think hard about whether you could take on this role. And finally, further thanks to Alan for master-minding all the arrangements for the terrifically successful trip to Dingle which many of us have so recently enjoyed. ■

*Julie Schroder*

# Field Meeting Reports

**Wednesday 6 July: Barr Beacon, Walsall.** Led by Graham Worton.

Starting from the main Barr Beacon Local Nature Reserve car park just before 7.00pm, this visit comprised a short walk down into Pinfold Lane Quarry before heading for the war memorial on Barr Beacon summit. Along the way, Graham introduced the geology of Barr Beacon and the surrounding landscape, and told us about the 'The Purple Horizons Project' with issues relating to conservation on a site such as this.

Barr Beacon hill is situated approximately 4.5km east of Walsall centre and forms a ridge high above the surrounding landscape. At around 227m in height, it forms the second highest point in the Black Country after the Rowley Hills. Walking from the car park to Pinfold Lane Quarry, Graham explained how reading the local landscape can tell us much about a site. Steep slopes, cut faces and trees of varying maturity are clues to an elevated landscape that people have historically worked for minerals and timber. Pinfold Lane Quarry was worked for sand and gravel until around 70 years ago before being abandoned to nature. ►

*View west from Barr Beacon summit*

## The Purple Horizons Project

Purple Horizons is one of five National Biodiversity projects designed to restore extensive and fragmented lowland heath and acid grassland habitats and link them via green corridors. Local councils in conjunction with Natural England and the Wildlife Trusts are leading the projects and Purple Horizons includes 10,000 hectares across the Birmingham conurbation from Sutton Park, to Walsall and Cannock Chase and the Staffordshire moorlands. On Kinver edge, a similar project is being undertaken which links it to similar habitats in North Worcestershire.

At the project outset, Graham and the Geopark team convinced the organisers about the role of geology and its relationship to the underlying soils that provide this important habitat, in order to gain some funding for conservation work. He made the point that, apart from Shire Oak Quarry in Walsall, Barr Beacon and Pinfold Lane Quarry were the best places to show schools and the public how geology leads to heathland habitat formation. This scheme is the only one that includes any geology.

## Pinfold Lane Quarry

*Pinfold Lane Quarry, Barr Beacon LNR*

The sedimentary stratigraphy forming Barr Beacon is first glimpsed via the sandy gravels along the wooded Monarch's Way (locally Beacon Way) and layered rock faces through the trees, on the way to Pinfold Lane Quarry. On entering the quarry, the strata are displayed in a magnificent high exposure with a scree slope formed from large, rounded pebbles.

Two different horizontal layers are clearly displayed within the exposure. The upper layer is harder than the lower, which explains why the ridge is here. The two layers appear distinctly different. They belong to the Chester Formation (formerly the Kidderminster Conglomerate) and the Hopwas Breccia Formation.

**The Chester Formation** forms the harder upper layer and comprises pinkish poorly cemented pebbles (as the name 'conglomerate' suggests) that vary in size, shape, colour and lithology. Generally rounded, the pebbles vary from coarse gravel to cobble size and include predominantly quartzites but also volcanic ashes, limestone and granites. Such lithologies are not common to the Black Country. Whitish spots on pebble surfaces hint at where they have been pushed together during burial and are known as 'contact marks'. The characteristics of the pebbles suggest they have been transported a long way in a high energy environment that smoothed them. The Chester Formation's contact with the lower layer is uneven and suggests scouring and erosion, which also hints at the transport medium that brought the pebbles here. Similar pebbly layers can be tracked north to Cheshire and south to Budleigh Salterton in Devon, and beyond to northern France.

The popular view is that the pebbles were deposited within a vast powerful braided river known as the Budleighensis, named after Budleigh Salterton. Imbrication (lining up) of the pebbles within this layer show that the river originated from the eroding Variscan/Hercynian mountain chain in northern France, around 260Ma, and flowed northwards through the Worcestershire graben and the Midlands before discharging onto the Cheshire plain. With the UK located further south than today, conditions would have been much hotter. A good modern example for this environmental setting is the River Nile flowing northwards through the Sahara Desert. ►

**The Hopwas Breccia Formation** (below the Chester Formation) is much sandier and contains smaller coin-sized pebbles that are angular to rounded in shape and comprise quartz and mudstone. This layer shows cross-bedding and is well cemented making it more stable and able to stand at a sub-vertical angle. Reddish iron oxide cement gives the layer its colour.

The older Hopwas Breccia dates to between 250Ma and 235Ma and the sedimentary features within indicate deposition in a relatively lower energy fluvial environment with some possible aeolian input. This layer is believed to have formed within a hot desert basin, subjected to cyclic intense downpours, flash flooding, drying out and burial under desert sands, similar to many terrestrial desert regions seen today.

**Geology and its role in the Purple Horizons Project**

Heading west from Barr Beacon, the geology changes to sandstones, conglomerates and mudstones belonging to the Upper Carboniferous Enville Member and Halesowen Formation. Further west, the geology changes again to mudstones, siltstone and sandstone layers forming the Coal Measures stratigraphy that defines the Black Country coalfield. These softer strata form a much lower lying landscape with totally different soil types and habitats.

The geological conditions found on Barr Beacon are ideal for lowland heath habitats that require well drained, acidic (gravelly or sandy) soils, which are nutrient poor. Typical lowland heath flora include heather, gorse, bracken and grasses. The mauve colour of heather in the autumn gives the Purple Horizons project its name.

The exposed rock faces in Pinfold Lane Quarry also provide another important habitat for wildlife. Pockmarks in the rock faces are partly due to dislodged fragments but also result from sand martins and burrowing solitary wasps, bees and other insects building nesting sites.

To support the Purple Horizons project, the 'Sands of Time' idea was born. Through interpretation boards and leaflets, this idea informs the public and schools about how the local landscape formed, the geological features contained within it, and how the geology influences soil types and biodiversity over the Purple Horizons project area.

*Barr Beacon War Memorial*

**Conservation**

Vital for the Purple Horizons Project to be successful is the need for conservation and ongoing site maintenance. The plant species - gorse, heather, bramble - make the heathland and acid grass land habitat unique and this in turn attracts a unique fauna. However, this habitat's survival is delicately balanced. It is important that ground cover does not become too established or the soils too nutrient enriched, as this will lead to secondary growth, such as birch, sycamore and elderberry, taking over to create more woodland type habitats. ►

As we have found in our conservation days at Pinfold Lane Quarry, another problem with too much vegetation is that it obscures rock faces. As can be seen from the scree slope within Pinfold Lane Quarry, the Chester Formation layer is unstable enough and prone to collapse without vegetation giving a helpful root. This necessitates keeping the public away from the rock face for health and safety reasons using fencing and barriers. Vertical rock faces and mature trees also provide their own individual problems that require specialist rock climbing techniques, chainsaws and poison to solve.

**Barr Beacon**

Finishing at the War Memorial on Barr Beacon summit, with the light fading, Graham spoke about the view, further conservation issues and the various stones used to construct the toposcope. The structure is mostly built from Portland Stone with some volcanic slates, similar to Borrowdale Slate, used for flagstones. The toposcope is a rounded plinth on top of which sits a panoramic disc pointing out what can be seen in the surrounding view: the Cannock Chase Plateau to the north; Hopwas village, (which gives the breccia its name) to the north-east; low-lying land formed from Triassic Mercia Mudstone and Jurassic mudstone and limestone underlying Warwickshire to the south-east; Permo-Triassic sandstone beneath the Birmingham Plateau to the south; the Rowley Hills to the south-west; the Malvern and Abberley Hills beyond to the south-west; the Clee Hills and Wrekin in Shropshire to the west.

*Damaged toposcope, Barr Beacon*

Unfortunately public misuse of the toposcope has damaged the disc and partly destroyed the information. Another issue is the unmanaged trees surrounding the structure that have grown to obscure the view from the hill summit because the park management want the trees to be beautiful and tall. At the end of the day, conservation is a delicate balancing act to protect endangered features, create new habitats and manage conflicts of interest between various parties whilst influencing public perception of the natural world. This is all important for the Purple Horizons Project to be successful.

I would like to thank Graham for another very interesting outing and no doubt BCGS members will be returning to Pinfold Lane Quarry soon to help keep up the conservation work.

*Andy Harrison*

**Sunday 18 September: Stiperstones.** Led by Albert Benghiat (Chair, Shropshire Geological Society).

**Introduction**

This was a joint trip with the Lickey Hills Geo-Champions, which aimed to examine the Ordovician Stiperstones Quartzites in Shropshire and compare them with those of similar age in the Lickey Hills to the south of Birmingham.

We met at the Stiperstones NNR Knolls car park, and Albert first gave us an overview of the geology of the area. During a period of volcanic activity known as the 'Uriconian' in late Precambrian times (c.566Ma), a NE/SW rift occurred between the Pontesford-Linley and Church Stretton faults. ►

Longmyndian sediments accumulated within the rift valley with Uriconian volcanics on either side. By Cambrian times the Avalonian micro-continent had begun its northwards drift as the Iapetus ocean between Avalonia and Laurasia began to close. Within this ocean the mudstones of the Tremadoc Shineton Shales were laid down, followed by the Stiperstones Quartzite Formation in the following Arenig age. The plates were in continuous motion during these times as subduction was ongoing. We were not able to examine the Tremadoc/Arenig boundary, but it is known that the mudstones were deposited in a deep open marine setting whereas the quartzites were laid down in a shallow marine coastal environment.

**Precambrian**

The trip started with a short walk to the east of the car park to identify the line of the Pontesford-Linley fault and the Longmyndian beds that had accumulated within. The Pontesford-Linley Fault forms a gentle change in slope on the horizon. Recognising the fault and the volcanics on its eastern side took a bit of the eye of faith. A small exposure of the tuffs was seen by the roadside, with a good exposure of the Longmyndian sandstones a little further on.

*Longmyndian sandstones, east of the car park*

*Shineton Shales in the car park*

**Ordovician - Tremadoc age**

Back at the car park we examined a small exposure of shales. These belong to the Shineton Shales Formation of Tremadoc age and represent an open marine depositional setting. The Shineton Shales are described by BGS as "grey or green shaley mudstones with interbedded sandstones at some levels".

Along the footpath up to the Stiperstones ridge there is a conformable transition into the black, flaggy micaceous siltstones of the overlying Habberley Formation, the junction assumed to be at the first appearance of black siltstone. This boundary was not observed.

**Ordovician – Arenig age Stiperstones Quartzite Formation**

Towards the top of the path we reached the junction with the Stiperstones Formation, which forms the entire Stiperstones ridge and dominates the local landscape with its characteristic rocky outcrops or 'tors'. On reaching the ridge we first stopped at a cairn made of quartzite blocks. There were many blocks that exhibited vuggy porosity, something not seen within the Lickey Quartzite. The colour is a fairly consistent pale grey. Lenticular deposits of grit-sized sand were seen here and in many exposures, again not seen at the Lickey Hills. ►

*Cairn on the Stiperstones ridge*

The next location was an outcrop to the south of the cairn, showing what has been interpreted as a large ripple on the bedding plane. It was the only one on this surface and no others were seen elsewhere. It is not as convincing as those we see in Warren Lane quarry at the Lickey Hills, but nevertheless suggests a relatively shallow depositional environment of around 20m. Bedding planes are clearly visible in many places, emphasized by weathering. Cross-bedding, found at several of the tors, provides evidence that the quartzites were mostly laid down in a shallow marine setting.

*Large ripple feature*

A common feature of the tors is the degree of jointing and the open nature of the joints and some bedding planes. The joints have resulted from periods of folding and faulting. The brittle nature of the quartzites has led to fracturing rather than bending. This has probably been aided by a lack of clay beds which would have enabled some sliding and flexure.

*Shallow marine bedding features visible in this tor*

*(See front page for a photo of our lunch stop. Ed.)*

During the Quaternary glaciations freeze-thaw conditions undoubtedly led to the opening of the joints and some bedding planes, creating the features we see today. In comparison, the quartzites of the Lickey Hills have mostly been exposed due to quarrying in the last few hundred years and therefore have fresh surfaces. Block fields surrounding the Stiperstones tors are further evidence of glacial and periglacial conditions along the ridge. Block fields, also known as felsenmeer, are a direct consequence of freeze-thaw action. The blocks can move down slope in a process known as solifluction.

*Block field or 'felsenmeer' below a tor*

Heading down from the ridge, we stopped to visit a small quarry with excellent exposures of the Habberley Formation. The shales exposed here are darker and more fissile than the underlying Shineton Shales seen earlier in the car park. The near vertical bedding showed that significant folding had occurred. A chevron fold noted in a loose block indicated that tight folding had occurred during a period of compression. At the right hand edge of the quarry there was a recognisable fault with a fault breccia and yellow staining.

**A brief comparison of the Stiperstones and Lickey Quartzites**

The age range of the Stiperstone quartzites that we visited is likely to be significantly less than in the Lickey Hills. The Stiperstones ridge only exposes a few beds, whereas the antiform at the Lickey Hills exposes a greater range of beds. Similarly, the diversity of the sandstones of the Stiperstones is less ►

than occurs at the Lickey Hills. Clay interbeds are a common feature in the Lickey Hills, but apparently absent from the Stiperstones quartzite. The colour of the Stiperstones quartzite is a fairly uniform light grey, in contrast to the Lickey Hills where red staining commonly seen.

The Stiperstones have been exposed to glacial and periglacial conditions severely impacting their current condition. The exposures of Lickey Quartzite are a product of quarrying over the last couple of hundred years and are therefore much less weathered than the Stiperstones.

This field excursion was a wonderful opportunity to visit this beautiful part of Britain, taking in the magnificent views over the Welsh borderlands on a bright late summer's day. An open invitation was extended to Albert for the SGS to come to the Lickey Hills for a day of exploration led by members of the Lickey Hills Geo-Champions group.

We extend our thanks to Albert Benghiat (SGS Chair) for leading the trip, and to his SGS colleague, David Smith who inspired this visit after visiting the Lickey Hills, and for his input during the trip. We look forward to further collaborations, in the Lickey Hills, and perhaps another visit to Shropshire. ■

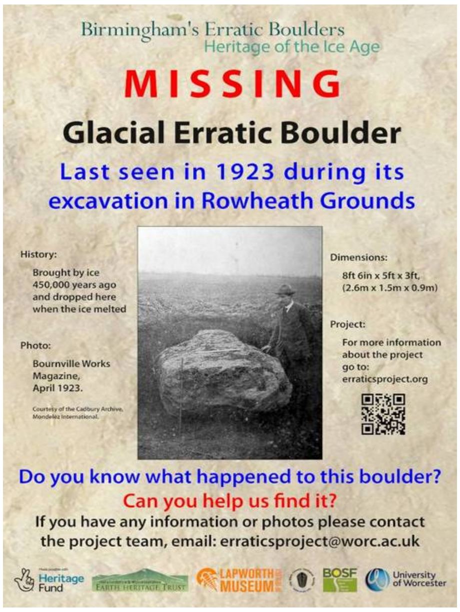
*Ray Pratt*

# Birmingham's Erratic Boulders: Heritage of the Ice Age

## Temporary Exhibition at the Lapworth Museum

There is much to report since my last up-date, notably the launch of our temporary exhibition at the Lapworth Museum on 14 September. This was a major team effort to assemble information panels and exhibits exploring all the many aspects of the Erratics Project to date. Thanks go to Lizzy and Jon at the Lapworth Museum, and designer Antony for providing this fantastic showcase for the Erratics Project's achievements and future plans. There is lots of interest here, so do make sure you go and have a look! You have until mid-January 2023 to visit the exhibition.

*'Birmingham's Boulders' exhibition at the Lapworth Museum of Geology. Photo by Roy Starkey*




*The Missing Boulder Campaign*

Again at the Lapworth Museum, erratics project volunteers were delighted to join in the 'Ice Age Explorers' family day. Children's activities kept the volunteer team busy all day, and two guided walks to see Birmingham University's Aston Webb erratic boulder were very well attended. Research is on-going to revise the interpretation of this massive boulder. Thought for many decades to be composed of basalt from the Rowley Regis area, two recent XRF investigations have revealed it to be largely sedimentary, with just a small percentage of basalt. Another erratics-themed Lapworth family event 'From Fire to Ice' will take place on Saturday 26 November. ►

On 10 September we had a gazebo at Rowheath Pavilion as part of Bournville's Heritage Day. Here we were able to introduce visitors to what must surely be the oldest 'heritage' in Bournville, with our Erratic Boulder trails 1, 2 and 7 including some fine specimens in the Bournville area, and a small one hidden amongst the trees not far from the Pavilion. We also raised awareness of a missing boulder of enormous size (see poster above). We would love to solve this mystery during the course of the project! Can you help?

*The trail launch cycle team returning to base in Cannon Hill Park*

The following day, 11 September, a valiant group of cyclists led by volunteers set off from Cannon Hill Park to launch Trail 7, 'Boulders by Bike', a 20km circular cycle trail visiting many of Birmingham's best erratic boulders.

With many parts of the project successfully completed, the next few months will focus on planning future events and activities. The remaining trails will be launched through the spring and summer months next year. ■

*Julie Schroder*
*(BCGS rep. Erratics Project steering group)*

For more information:
https://erraticsproject.org/
https://www.facebook.com/birminghamerratics
https://www.twitter.com/erraticsproject
https://www.instagram.com/erraticsproject

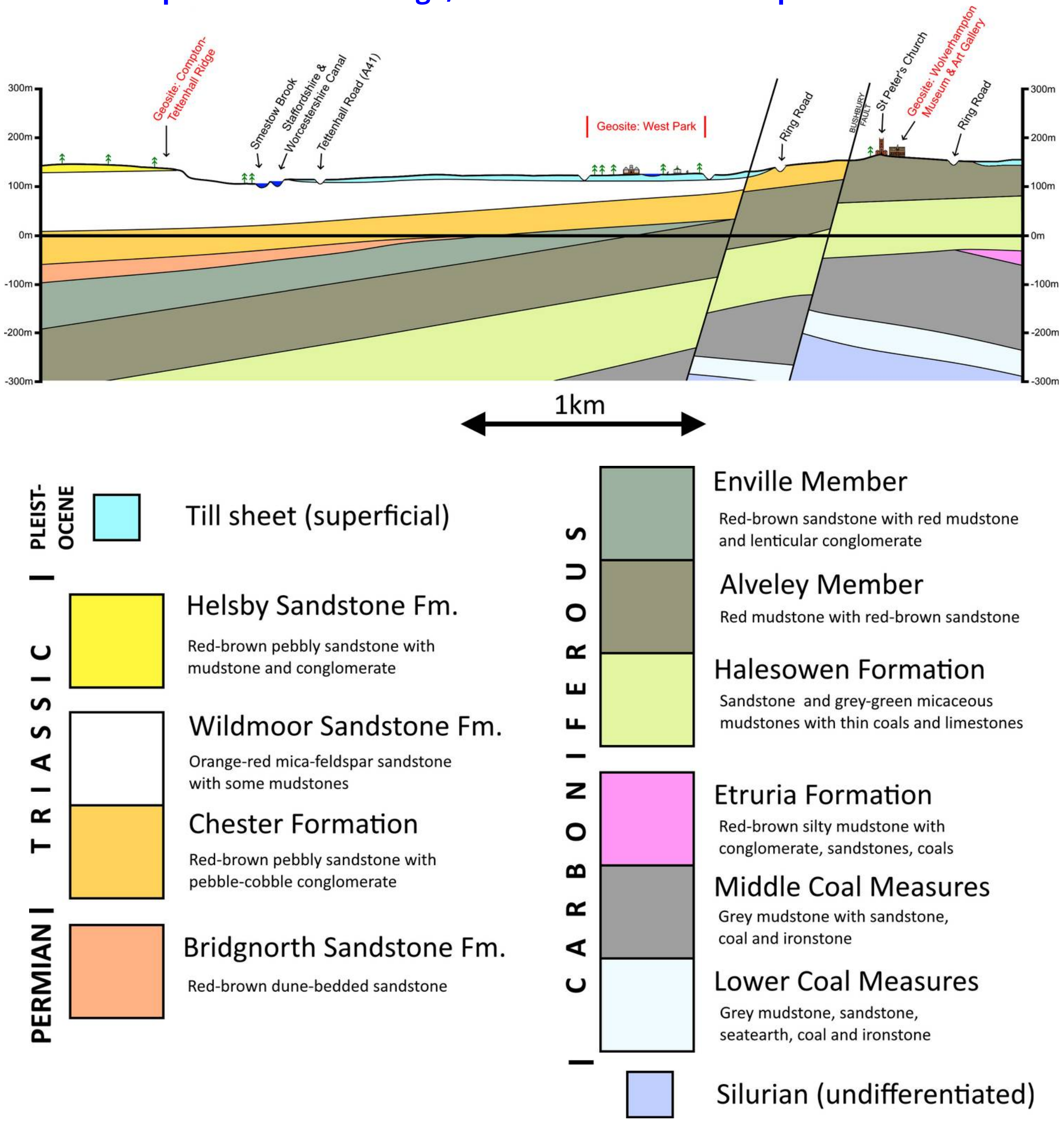
## Murchison In The Library

When you visit a stately home do you always head for the library? All those bound volumes collected in the age of scientific enlightenment - what treasures from the early days of Earth Science must be held on shelves accumulating dust. But wait, what's this? These very well read folks clearly knew what to collect for posterity! For any serious students of Murchison and his work this copy is actually available for perusal. *(Please contact the newsletter editor for further information.)* ■

*Mike Williams*

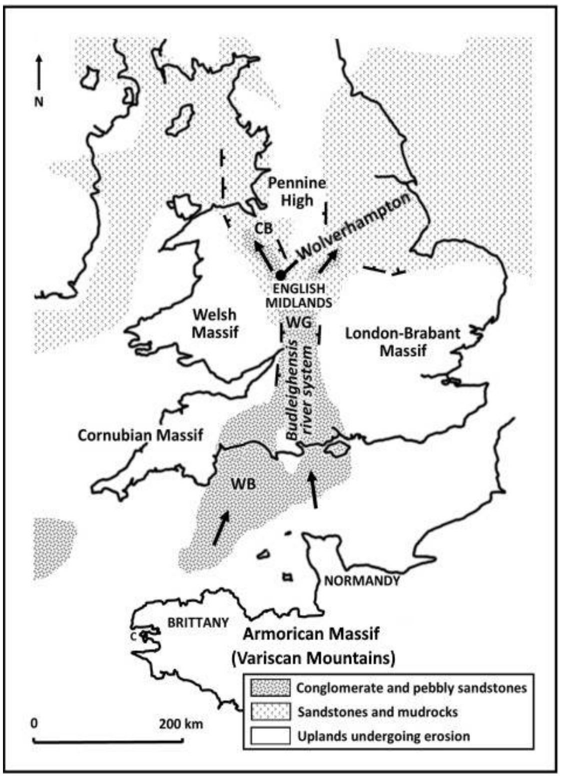

# Matt's Maps No. 9

## Compton-Tettenhall Ridge, West Park & Wolverhampton Museum




From the golden palace of Molineux to the Elizabethan farmhouse of Moseley Old Hall, this month's article takes us to the north-west corner of the Black Country Geopark. Wolverhampton holds the totally arbitrary, but superficially impressive distinction of being the only city in the Black Country. A centuries-old question often recurs throughout pubs in the West Midlands – is Wolverhampton actually part of the Black Country? Those who exclude it may do so on the basis of geology, as the surface geology of Wolverhampton is quite distinct from the industrial centres further to the 'traditional' Black Country in the east. ►

The Carboniferous Period (359-299 million years ago) is appropriately named for the vast coal deposits laid down in the low-lying swamplands in this interval. But while those ancient ecosystems were transforming into the fuel that would drive the industrial revolution, the Earth's tectonic plates continued their unrelenting journey over the face of the planet. From the latter parts of the Carboniferous and into the early Permian period (299-252 million years ago), the vast Variscan mountain range was growing across much of southern and central Europe. Its effects on climate, volcanism and geology were far-reaching, and included the intrusion of the Rowley lopolith in our own region. After this mountain building event slowed, the Earth's crust began to relax.



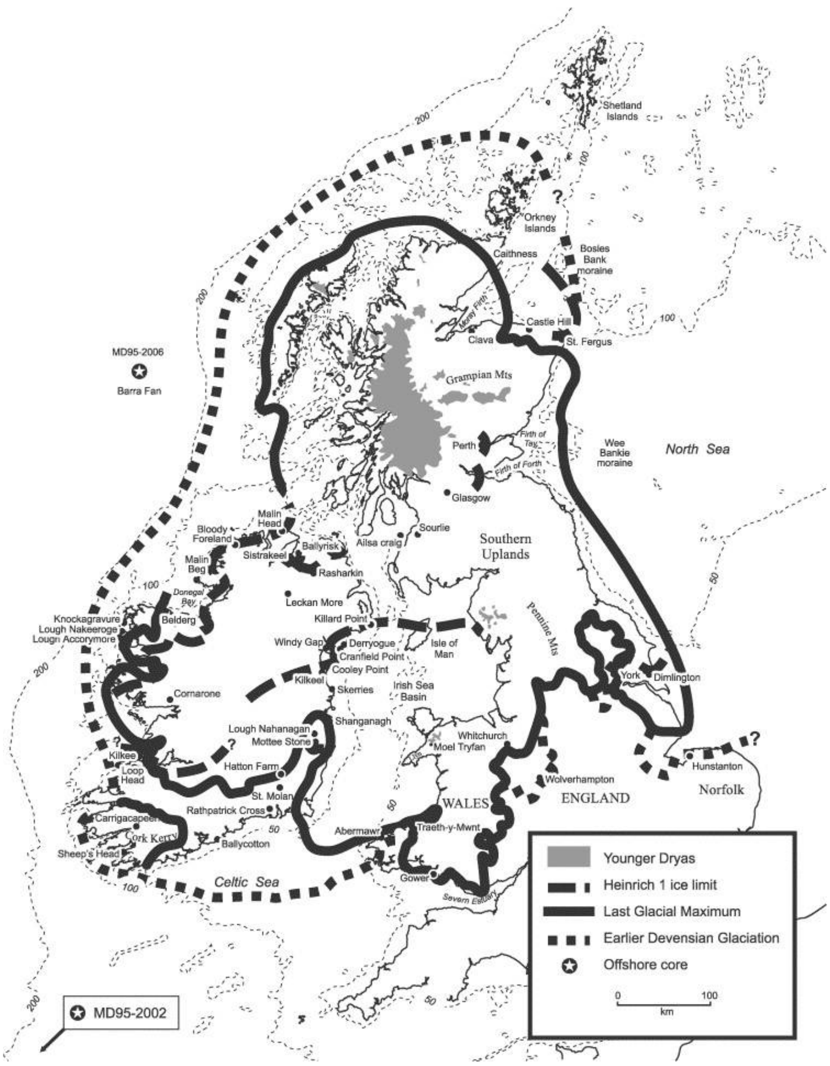

*Palaeogeography of Britain and northern France during the Early-Middle Triassic, showing the movement of a river system from south to north. WB=Wessex basin, WG=Worcester Grab, CB=Cheshire Basin. Image is modified from Radley & Coram (2016)*

So far so good, but what does any of this have to do with Wolverhampton? Well, as the Variscan mountains began to erode, subsurface fault lines began to move. The result was that an area extending from Wolverhampton in the east, to Telford in the west, began to sink. This structure is the local expression of a structure called the Worcester Graben. As it sank, the low-lying landscape was steadily filled up by sediments reflecting the new environment that had formed in the arid interior of Pangaea, the newly formed supercontinent. Initially that environment was a desert with endless miles of sand dunes. Later, during the Triassic (252-201 million years ago) seasonal rivers migrated across this landscape from the distant southern mountains. The evidence for all of these can be clearly seen in the rocks exposed to the west of the Smestow Valley, and notably along the roadside outcrops of the A41 near Tettenhall, appropriately known as 'The Rock'. This is part of the wider Compton-Tettenhall Ridge geosite and marks the boundary between two groups of sandstones of varying hardness, the older Wildmoor Sandstone and the overlying Helsby Sandstone (also known as the Bromsgrove Sandstone). These rocks were widely employed as building stones in the past, as can be seen in the oldest structures in the Tettenhall area. Perhaps most notable among these is the stunning St Michael & All Angels Church, whose oldest portions date back to the 13th century.

I've discussed some of these sandstone deposits in previous articles, as they extend along the whole western edge of the Black Country and define the landscape around Stourbridge, Kingswinford, and much of South Staffordshire. In fact, the belt of sandstones from the Permian and Triassic periods reaches from Devon in the south, branches in the Midlands and spreads into both the Irish and North Sea. ►

*St Michael & All Angels Church, Tettenhall*

As we move east, across the Smestow Valley (subject of a future article), a different and much younger material overlies these sandstones. The surface deposits are called till, and are mostly made up of sand and clay laid down during the last ice age. Till is laid down by the tongues of glaciers that would have spread from mountains in the Lake District and SW Scotland during the last ice age. The reason we can be so confident of the source of these glaciers is because as well as till, Wolverhampton is home to numerous glacial erratics – metre-scale blocks of bedrock ripped from the mountainside and transported hundreds of kilometres by rivers of ice. If you're reading this then you're almost certainly already aware of the fantastic Birmingham erratics project, which is aiming to document and celebrate the erratics of Birmingham and Worcestershire. Interestingly, Wolverhampton's erratics have a different source area to those of Birmingham, which is probably because they were transported during the last episode of widespread glaciation in Britain (whereas Birmingham's erratics are almost half a million years older). In fact, these erratics are evidence that Wolverhampton marked the southernmost extent of British glacial advance during the last ice age. This so-called 'Wolverhampton Line' can be seen on the map below. The best place to see the Wolverhampton glacial erratics is probably West Park, the second geosite covered in this month's cross-section. ►




*Left: Map showing the maximum extent of ice sheets during the last glacial period, modified from Bowen et al. (2002). Right: A glacial erratic in West Park, image by Philip Halling.*

The third and final geosite covered here is slightly less geological, but nonetheless a cultural gem of the Black Country. Wolverhampton Museum and Art Gallery possesses one of the largest geological collections in the local area, but unfortunately most of this is not on display at any given time. Both the building, a neoclassical marvel constructed from Jurassic limestone, and its extensive art and history collections, pay tribute to the wealth of Wolverhampton during the late industrial age. The area was a hub for the industrialists whose fortunes were mined, forged and crafted from the coalfield to the east.

Wolverhampton's fortunes have undoubtedly declined alongside its industries over the past century, but the survival of cultural institutions from that time connect people in the present day to that distant past. West Park recently hosted the Commonwealth Games cycling time trial events, and the newly renovated train station is a neighbour to the first government department headquarter based outside of London (Ministry of Housing, Communities and Local Government in the i9 building). Wolverhampton was created by ancient deserts, ice ages, and industrial revolutions, but it is a city which is looking confidently towards its future. ■

*Matthew Sutton*

**References and Further Reading**

**Image of Early-Mid Triassic river system** is modified from the paper below.

Radley, Jonathan D., and Robert A. Coram. "The Chester Formation (Early Triassic, southern Britain): sedimentary response to extreme greenhouse climate?" Proceedings of the Geologists' Association 127, no. 5 (2016): 552-557. https://www.sciencedirect.com/science/article/pii/S0016787816300955

**An outline of the history of Tettenhall church:**

http://www.historywebsite.co.uk/articles/Tettenhall4/Church.htm

**Map of the limits of glaciation** in the British Isles is modified from the paper below

Bowen, D. Q., F. M. Phillips, A. M. McCabe, P. C. Knutz, and G. A. Sykes. "New data for the last glacial maximum in Great Britain and Ireland." Quaternary Science Reviews 21, no. 1-3 (2002): 89-101. https://www.sciencedirect.com/science/article/pii/S0277379101001020

**Image of West Park glacial erratic** is by Philip Halling 'Erratic rock in West Park':

https://www.geograph.org.uk/reuse.php?id=5719711

**For more on the glacial erratics** of the West Midlands, see the Birmingham erratics project website:

https://erraticsproject.org/

## Mike's Musings No. 41 - 'Metamorphic Rocks: All Change Please'

Having discussed the **primary** world of igneous rocks, I now consider the first of the two main categories of **secondary** or **derived** rocks. Metamorphism is the transformation of any pre-existing rock by applying heat or pressure, resulting (only) in a change of mineral composition or texture. Note that in this strict sense there should be no overall change in chemical composition, and the rock should at all times remain in a solid state. The degree of transformation can be either very slight or very severe, resulting in the development of many 'metamorphic series' in which a rock can pass through several changes of character, much depending on the initial rock type and the process involved; processes such as: ►

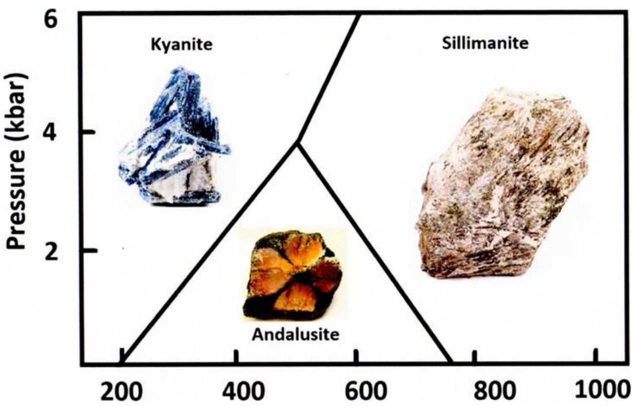



*Fig. 1 The Aluminium Silicate polymorphs $Al_2SiO_5$*

**Recrystallisation:** simply involves a change in the physical nature of a particular mineral crystal, a simple example being a growth in the size of calcite crystals in transforming limestone into marble.

**Phase change:** involves a transformation of one mineral into another without any change in chemical composition. The favourite example given in many texts involves the trio of andalusite, kyanite and sillimanite: all have the chemical formula $Al_2SiO_5$, but each exists only within a specific range of temperature and pressure (Fig. 1, above). This can help to determine the pressure-temperature conditions present during the transformation of a rock mass.

**Neocrystallisation:** involves the growth of new minerals as the temperature and pressure conditions are ramped up. Such is the case with **'spotted slate'**. Other examples are mentioned below. This, again, is helpful in elucidating the metamorphic history of a rock.

*Fig. 2 Spotted Slates: Andalusite needles (left), Variety Chiastolite with its characteristic cruciform inclusions (centre), Cordierite spots (right)*

If the pressure-temperature environment increases beyond the simple range of metamorphic change, a rock may begin to melt, a process known as **anatexis**. This results in the formation of magma and hence passes into the igneous realm – one definition of where metamorphism ends and magmatism begins!

In addition to various **processes**, different **types** of metamorphism are also recognised, some of which are probably more familiar terms in the metamorphic glossary.

**Thermal (or Contact) Metamorphism:** concerns change principally due to rise in temperature. This usually takes place at relatively shallow depths around the margin of an igneous intrusion. It may involve a change in the texture of a rock (it gets 'baked'), such as a mudstone transforming into a very hard, brittle and splintery rock called a **hornfels**, or the development of new minerals in **'spotted slates'**, (Fig. 2) as mentioned above. Some texts also separately describe **hydrothermal metamorphism**, which introduces changes due to the heating effect of hot fluids of varying composition adding new material to the original rock mass. This contravenes the strict definition of metamorphism, as given above, (in which there is no overall change in chemistry), and passes into the realm of **metasomatism**, which does allow for the introduction of new material.

**Dynamic Metamorphism:** concerns change principally due to increasing pressure. Simple burial of a pile of sediments (sometimes referred to as **burial metamorphism**) can be regarded as the 'soft' end of this spectrum; perhaps the best demonstration is given by changes to layers of peat as they transform into different grades of coal, and to which I shall return. Higher grades of change occur in more confined volumes of rock, notably in fault zones where shear stresses can be very great, with the development of 'rock flour' (or **mylonite**, which has a variable composition dependent on the parent rock) due to intense crushing, or ultimately (with partial melting) into **pseudotachylite** (so-called because it resembles a glassy basaltic rock known as tachylite).

**Shock Metamorphism:** this might be regarded as the upper end of the dynamic spectrum, and is (thankfully) a less frequent type of metamorphic event associated, as the name suggests, with sudden application of immense pressure, specifically meteorite impacts. Ironically, this takes place more or ►

less at the surface, and most of the changes occur almost instantaneously, including any temperature effects such as the sudden vaporisation of the target rock. In such cases, the very common mineral quartz ($SiO_2$) may transform into one of several ultra-high pressure polymorphs. Other more exotic high pressure mineral phases have also been described in association with impact craters, some of which are otherwise unknown.

*Fig. 3a Decussate texture in marble from Greece*

**Regional Metamorphism:** concerns changes which take place at greater depth and usually occurs in association with large-scale tectonic activity, where more severe conditions of both temperature and pressure are involved on a grander scale. This leads to the concept of **metamorphic facies**, which I will develop further below.

These introductory remarks establish the generalities of the metamorphic realm, but the real interest lies in classifying, or putting some order, into the great variety of metamorphic rocks. The essential factor to recognise is that everything that follows really depends on the starting material – and this includes all three kinds of rock; igneous, sedimentary, or indeed metamorphic (there is no reason to exclude the latter: rocks may be subjected to metamorphism many times, just as they may be involved in many tectonic events). The second point to note is that metamorphic change is a progressive process that can be bi-directional, such that the initial rock may pass through several different character states as the degree of change increases, or, indeed, decreases! The latter situation is described as **retrogressive metamorphism**, which is mostly confined to **regional** scale events.


*Fig. 3b Decussate texture in amphibolite from Raasay*

Simple monomineralic rocks (those composed chiefly of a single mineral species, such as quartzite, amphibolite or limestone) are particularly prone to the development of a **decussate** texture (Figs. 3a, 3b & 4) in which the crystals grow and mesh together: "not at random, by the operation of a mathematical law of chance, but as part of a definite mechanical expedient for minimizing internal stress" (quoted from 'Metamorphism' by Alfred Harker). Recall that Nature is intrinsically lazy and strives to produce the lowest energy state, or minimum entropy, achievable: a good analogy in the igneous world is the development in lavas of a regular polygonal pattern, ideally hexagonal, of cooling joints "by ►

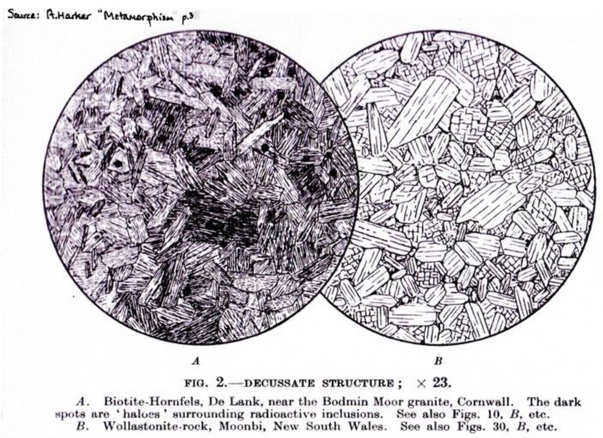


*Fig. 4 Decussate texture in thin section (from Harker's 'Metamorphism')*

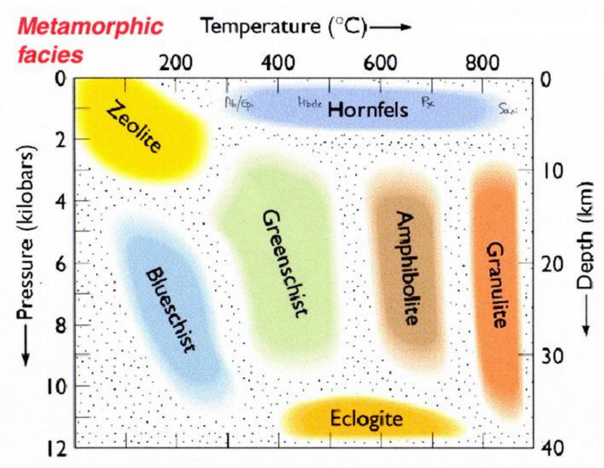



*Fig .5 Metamorphic Facies.*

uniform contraction towards evenly spaced centres" (as Arthur Holmes elegantly puts it): think Fingal's Cave or the Giant's Causeway as celebrated examples.

A whole panoply of metamorphic products based on the nature of the parent rock can be described, as shown by the various following 'metamorphic series' of rocks.

**Shale:** Slate, Phyllite, (Mica-)Schist, Gneiss, Granulite. 'Spotted slates' (Fig. 2, above) are the result of specific new minerals, notably andalusite, chiastolite and cordierite, forming from the initial 'clay mineral', of which there are many 'species'.

**Sandstone:** Ganister, Quartzitic-Schist, Quartzite.

**Limestone:** Marble. Impure limestones transform to marbles in which a whole host of new, many exotic, minerals appear with increasing temperature and pressure.

**Peat:** Lignite/Brown Coal, Sub-Bituminous Coal, Bituminous Coal, Anthracite.
(An alternative path for **Organic Matter** is the transformation into Graphite, or even Diamond.)

**Granite:** Gneiss, Granulite, Migmatite (part igneous)

**Basalt:** Greenschist, Amphibolite, Eclogite (Fig. 7)

*Fig. 6 Blueschist from the Ile de Groix, France*

*Fig. 7 Eclogite from Norway*

These examples relate to metamorphic rock-types, and in the realm of **Regional Metamorphism** can be extended to the useful concept of **metamorphic facies**, (Fig. 5) mentioned above, which recognises several types of metamorphic rock as forming under their own range of pressure and temperature. They are characterised by each having a distinct mineral assemblage.

Thus, **blueschists** (Fig. 6) include the minerals glaucophane or riebeckite which only occur in rocks formed under fairly high pressure but low temperature, such as exist in subduction zones. **Eclogites** (Fig. 7) are another striking rock type characterised by the minerals garnet and omphacite (a green ►

pyroxene) which are indicative of high pressure and temperature that form much deeper within subduction zones. **Granulites**, by contrast, are formed at high temperature and moderate pressure typical of high grade regional metamorphic terrains such as shield areas (the centres of ancient continental landmasses). They are characterised by having a granular texture of small crystals, mainly quartz, feldspar and orthopyroxene, but often with red garnets being the most conspicuous. If conditions reach the point of partial melting (**anatexis**) **migmatites** are formed, and although generally regarded as metamorphic rocks they, strictly speaking, grade into the igneous realm.

The other facies illustrated each indicate a different tectonic environment, which all together help to unravel the ancient histories of our continents.

Note the **hornfels** facies that occupies conditions of low pressure but moderate to high temperature. This typifies **contact, or thermal, metamorphism** as defined previously, and in which the growth of new minerals in clay-rich rocks leads to the development of 'spotted slate'. These are common around larger igneous intrusions such as the granites in Devon and Cornwall or the Lake District.

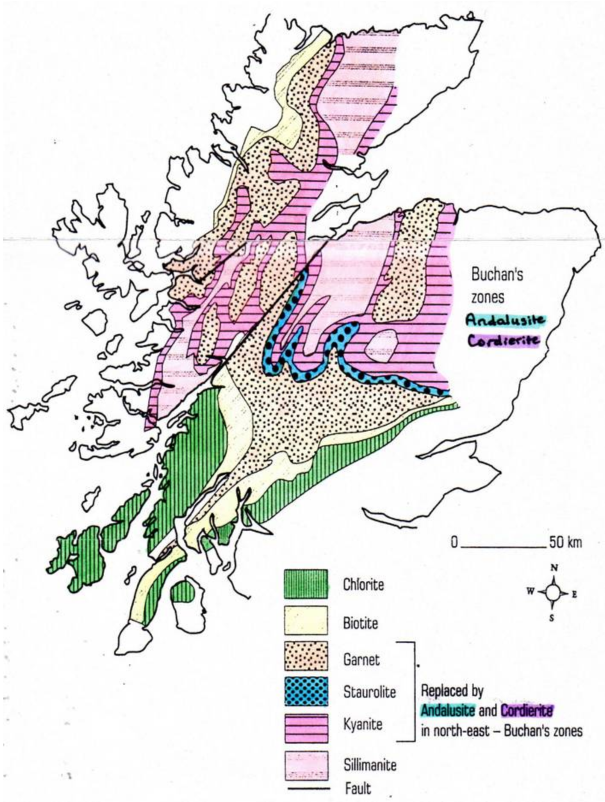



*Fig. 8 Barrovian Zones of Metamorphism*
*Image is modified from 'Geology of Britain' by Peter Toghill*

Much more can be said about the growth of new minerals during metamorphism. In the Grampian Highlands of Scotland, pioneering work by George Barrow in the early 20th century led to the recognition of different metamorphic grades within an area of **regional metamorphism** based on the presence of specific minerals that appeared as the intensity increased. The **Barrovian zones** (Fig. 8) devised in areas of meta-pelites (metamorphic rocks originally rich in clay minerals) were:

(low grade) chlorite biotite garnet staurolite kyanite sillimanite (high grade)

Further work has since recognised slightly modified mineral sequences dependent on the original rock types (such as the use of andalusite and cordierite in the north-east referred to on the map, which are known as **Buchan zones**). In some areas a degree of **retrogressive metamorphism** is indicated by, for example, garnet crystals having a chlorite or biotite rim where part of the garnet has been altered to a lower grade mineral. By similar means, specialists examining thin sections are able to detect much more from the different textures and relationships seen between minerals.

As well as metamorphic rocks having characteristic mineralogies, it will be apparent from the nature of many of the rock types mentioned that the development of a distinctive layered **texture** is also a common characteristic of metamorphic rocks. This is exemplified by **slaty cleavage**, induced by lath-like or platy minerals becoming re-orientated into a common alignment by the application of pressure on mudstones. In other lithologies, layering takes the form of **foliation** where pressures induce a ►

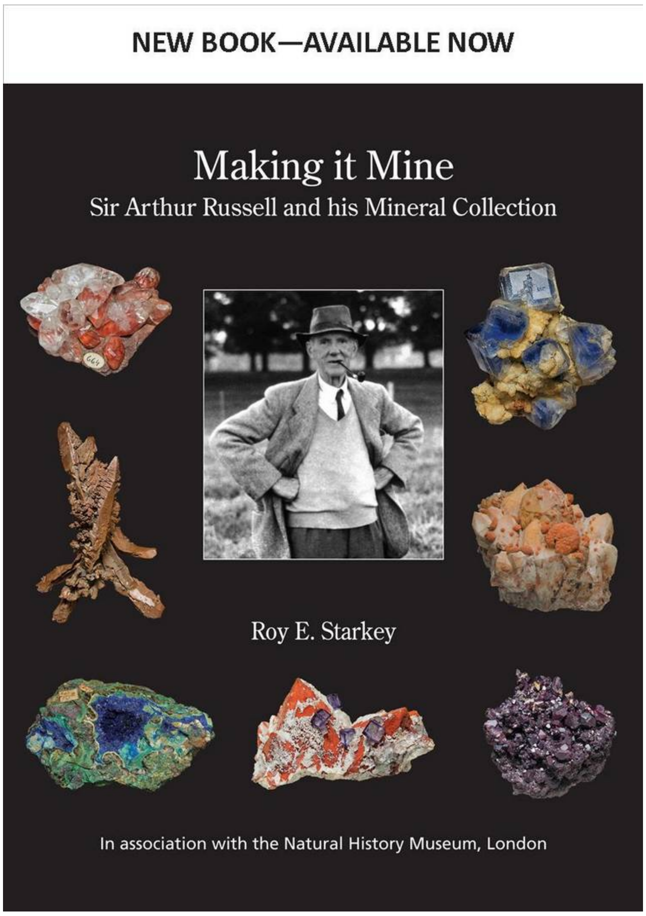
segregation of different minerals into separate layers, most conspicuously into felsic and mafic portions, typified by the layering seen in schists and gneisses.

One final feature worth a mention is the metamorphic equivalent of the igneous phenocryst. This rejoices in the term **porphyroblast**, of which I will have more to say in my next musing! ■

*Mike Allen*

# Making it Mine

*As a former member and Meetings Secretary for BCGS, we have been pleased to promote Roy Starkey's earlier publications: 'Crystal Mountains: Minerals of the Cairngorms' (2014), and 'Minerals of the English Midlands' (2018). Now we are delighted to introduce Roy's most recent publication, 'Making it Mine', a comprehensive biography of Sir Arthur Russell, and his mineral collection.*




Making it Mine explores the fascinating story of Sir Arthur Russell 6th Baronet as he pursued his quest to build the finest collection of British minerals ever assembled. Lavishly illustrated with more than 750 photographs and diagrams, including 445 previously unpublished images of specimens from Sir Arthur's collection, the book delves into his family history, the background to his passion for mineralogy and his single-minded determination to secure the very best specimens for his collection. The stories and people behind the specimens are woven into a compelling narrative together with sketches and anecdotes concerning the many colleagues and contacts that assisted him along the way.

Privileged access both to the Sir Arthur Russell Collection of British Minerals, and the Russell Archive, at the Natural History Museum in London has allowed the author to tell the story in detail.

The book will appeal to all those interested in British mineralogy, to mineral collectors and dealers, to historians of mineralogy, museum curators, university researchers and to anyone who is simply interested in the treasures of the natural world. This is neither a coffee table book nor a biography, but rather a blend of the two that takes the reader on an absorbing journey through the last 200 years of mineral collecting. ■

*For further information, or to order a copy, go to [www.britishmineralogy.com](www.britishmineralogy.com)*
*or email [roy@britishmineralogy.com](mailto:roy@britishmineralogy.com)*

*Roy Starkey*