The Black Country Geological Society

Newsletter No. 240

December 2016

Copy date for the next Newsletter is Wednesday 1 February

Contents:

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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 further information see our website: bcgs.info and Twitter account: @BCGeoSoc

Future Programme

Indoor meetings will be 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 from January 2016.

Please let Andy Harrison know in advance if you intend to go to any of the field or geoconservation meetings. If transport is a problem for you or if you intend to drive and are willing to offer lifts, please contact Andy with at least 48 hours notice.

Saturday 3 December (*Geoconservation Day*): Portway Hill, Rowley. Meet at St. Brades Close at 10.30. Directions: from Birmingham New Road (A4123) turn left onto Tower Road if coming from Birmingham, right if coming from Wolverhampton. Just after Bury Hill park, turn left onto St. Brades Close. Wear old work clothes, waterproofs and stout footwear. Please bring gloves and spades, brushes and trowels in order to excavate and expose more of the dolerite. Bring packed lunch. Finish at 2.30.

Monday 12 December *(Indoor meeting)*: Members' Evening. This is our annual chance for members to share their geological experiences in a sociable atmosphere with a Christmas buffet provided by the Society, with short talks from some of our members.

Monday 16 January 2017 *(Indoor meeting)*: 'Volcanics in Costa Rica'. Speaker: Andy Harrison.

Saturday 4 February *(Geoconservation Day)*: Rubery Cutting. In conjunction with the Lickey Hills Geo-Champions and directed by the Lickey Hills Rangers. Meet at 10.30 at the cutting by the junction of the slip road from A38 Bristol Road South, and Leach Green Lane, B45 9XS (SO 993 775). Parking under the flyover. Tools and equipment will be supplied by the Park Rangers. Bring your own gloves, hard hat, and high viz jacket if possible (not essential). Finish around 2.00.

Saturday 18 February *(Geoconservation Day)*: Wren's Nest. Details TBC.

Monday 20 February *(Indoor Meeting)*: 'The Wren's Nest - The Jewel in Dudley's Crown'. Speaker: Rob Broadbent, Friends of the Wren's Nest.

Saturday 4 March *(Geoconservation Day):* Portway Hill, Rowley. Meet at St. Brades Close at 10.30. 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 work clothes, waterproofs and stout footwear. Please bring gloves and spades, brushes and trowels for another session at this important site. Bring packed lunch. Finish at 2.30.

Monday 20 March *(Indoor meeting, 7.00 for 7.30 start):* AGM followed by **'New fossil reptiles from the Triassic of Tanzania: implications for the origins of dinosaurs and their kin'. Speaker: Richard Butler,** University of Birmingham.

Saturday 22 April *(Field Visit):* Mortimer Forest, Hereford/Shropshire Border. Details TBC.

Monday 24 April *(Indoor meeting):* 'A Teacher's View of Glacial Geology'. Speaker: David Pannett (Shropshire Geological Society).

Saturday 20 May *(Field Visit):* Return to the Brymbo Fossil Forest, Wrexham. Details TBC.

Saturday 17 June *(Field Visit):* The newly refurbished Lapworth Museum. Details TBC.

Procedures for Field Meetings

Insurance
The Society provides public liability insurance for field meetings but personal accident cover is the responsibility of the participant. Details can be obtained from the Secretary, and further helpful information can be found in the Code for Geological Field Work published by the GA and available on our website. Schools and other bodies should arrange their own insurance as a matter of course.

Health and Safety
If you are unsure about the risks involved or your ability to participate safely, you should contact the Field Secretary. Please take note of any risk assessments or safety briefing, and make sure that you have any safety equipment specified. The Society does not provide hard hats for use of members or visitors. It is your responsibility to provide your own safety equipment (eg. hard hats, hi-viz jackets, safety boots and goggles/glasses) and to use these when you feel it is necessary or when a site owner makes it a condition of entry. Hammering is not permitted unless specific permission has been sought and granted. Leaders provide their services on a purely voluntary basis and may not be professionally qualified.

Other Societies and Events

BCGS members are normally welcome to attend meetings of other societies, but should always check first with the relevant representative. Summarised information for approximately **two months** is given in our Newsletter. Further information can be found on individual Society web sites.

Teme Valley Geological Society

Monday 16 January 2017: 'The Anthropocene'. Speaker: Professor Ian Fairchild.

Events are held in Martley Memorial Hall. Contact John Nicklin on 01886 888318. For more details visit: http://www.geo-village.eu/ Non-members £3.

East Midlands Geological Society

Saturday 10 December: 'Geohazards in Central China; landslides in loess and the 2010 Zhouqu debris flow disaster'. Speaker: Dr Tom Dijkstra, Loughborough University & British Geological Survey.

Saturday 14 January 2017: 'The secret life of your mobile phone: metal supply and digital devices'. Speaker: Andrew Bloodworth, British Geological Survey.

Non-members are welcome. Meetings are usually at 6.00 in the Geography Dept. of Nottingham Uni, in the Sir Clive Granger Building. Further info: www.emgs.org.uk or email: secretary@emgs.org.uk

Shropshire Geological Society

Wednesday 11 January 2017: 'Fossils in Shropshire digitisation project: enhancing access to the county geological collection'. Guest speakers: Daniel Lockett and Jackie Tweddle, consultants to the FISH project for the Friends of Ludlow Museum.

Wednesday 8 February: A geophysical topic related to borehole logging and video surveys (exact title tba). Guest speaker: Kim Beesley.

Generally held in the Conference Room of the Shropshire Wildlife Trust HQ, 193 Abbey Foregate, Shrewsbury, SY2 6AH commencing at 7.00 for 7.30. A nominal charge is levied for attendance by non-members. Further info at: www.shropshiregeology.org.uk/

Warwickshire Geological Conservation Group

Wednesday 18 January 2017: 'The volcano that changed the World: Tambora and the great eruption in 1815'. Speaker: Dr. Ralf Gertisser (Keele University).

Doors open at 7.00 for coffee before a 7.30 start at St Francis Church Hall, 110 Warwick Road, Kenilworth CV8 1HL. For more details visit: http://www.wgcg.co.uk/ or email: WarwickshireGCG@gmail.com. There is a charge of £2.00 for non-members.

North Staffordshire Group of the Geologists' Association

Thursday 26 January 2017: 'A Medical Geology perspective of the effect of soil on human health'. Speaker: Dr Mark Cave (British Geological Survey).

Thursday 9 February: 'Digital Geological Mapping'. Speaker: Leanne Hughes (BGS and Vice-President of the Geologists' Association.

Non-members pay £2 to cover temporary membership giving them insurance cover. A field fee of £2 per head is normally charged for members and non-members to cover the leader's expenses. For field trip enquiries: Steve Alcock, Longfields, Park Lane, Cheddleton, Leek, Staffs, ST13 7JS. Tel: 01538 360431 or 07711 501028. Email: steves261@aol.com Further info: www.esci.keele.ac.uk/nsgga/

Lapworth Lectures

Monday 28 November: 'The ophiolite enigma resolved?' Speaker: Professor John Dewey, University of Oxford.

Lectures at 5.00 in lecture theatre WG5, Aston Webb (R4), University of Birmingham. All are welcome to attend and there is no admission charge. For further information phone: 0121 414 7294.
email: lapworth@contacts.bham.ac.uk web: http://www.lapworth.bham.ac.uk/events/lectures.shtml

Manchester Geological Association

Saturday 10 December at 13.30: Recent Discoveries in British Palaeontology
'The Incredible Ichthyosaurus: a reassessment of a British Jurassic Icon'. Speaker: Dean Lomax (University of Manchester).
'Dinosaurs from Wales'. Speaker: Cindy Howells (National Museum Wales).
'Digital techniques for understanding ancient life'. Speaker: Dr Russell Garwood (University of Manchester).
'Populating a post-extinction world: the resurgence of vertebrate diversity in the early Carboniferous'. Speaker: Professor Jenny Clack (Cambridge University).

Saturday 21 January 2017 at 13.30: Rare Earth Elements: vital commodities.
Three speakers, including Professor Frances Wall (University of Exeter).

Contact Jane Michael: email indoors@mangeolassoc.org.uk For further information about meetings go to: http://www.mangeolassoc.org.uk/ Visitors are always welcome. Unless otherwise stated, all lectures are in the Williamson Lecture Theatre, Manchester University, Oxford Road, Manchester.

Cardiff University Lecture Series - 'The Making of Wales'

Tuesday 13 December: 'The Greening of Wales'. Speaker: Dianne Edwards, Cardiff University.

Tuesday 10 January 2017: 'Exploring equatorial Wales: the life and times of our ancient tropical swamp'. Speaker: Chris Cleal, Amgueddfa Cymru - National Museum of Wales.

A monthly series of evening lectures in the School of Earth and Ocean Sciences that begin at 6.30 in the Wallace Lecture Theatre, Main Building, Cardiff University, Park Place, CF10 3AT. No booking needed and the general public are welcome to attend.

Editorial

In these dark winter days of political uncertainty and apprehension, it's a pleasure to able to report a few heartening developments within our Society and in our local geological world.

Firstly, on behalf of the Committee I would like to extend a warm welcome to our new Meetings Secretary, Roy Starkey. Many of you will already know Roy from his presentations at our meetings, and for his recently published book 'Crystal Mountains - Minerals of the Cairngorms'. Roy has already ►

asked us to express our particular fields of interest to help him in engaging speakers, and I urge you to respond to his request. The Society is for all its members, and the Committee needs your help to make it work for everyone. Roy takes over from Linda Tonkin who has been acting as Meetings Secretary for some time, as well as fulfilling her role as Honorary Secretary. Linda has completed the programme up to the next AGM, and we thank her for all her hard work in bringing together the varied and interesting indoor programme which we've enjoyed over recent years.

Secondly, we should congratulate BCGS member Roland Kedge on the successful culmination of his project to see the 'Great Stone' in Northfield given the recognition it deserves (see below). The unveiling ceremony was indeed a happy occasion - but what next? Is it time for a wider campaign to see more recognition for these urban relics of the ice age, not just in Birmingham but thoughout the Black Country? I hope some may be inspired by Roland's achievement to take on the challenge. Our urban areas badly need some geological focus, and this thought brings me neatly to the next cause for some celebration.

I'm pleased to announce the completion of the first stages of another project which has been close to my heart for some time. This is the 'launch' of the first of three self-guided web-based trails in a series: 'Building Birmingham'. The first trail, 'Town Hall to the Cathedral', covers Birmingham City Centre. (See below, p9 for more about this project.) Along with the urban geology potential of glacial erratics, maybe these trails will provide an incentive to others to develop a range of Building Stones trails covering various urban centres in the Black Country. I hope so. The web space is there, waiting...

Last but certainly not least, I'd like to pick up the threads of our Chairman's informative talk (17 October) about the Black Country Geopark. The four Black Country boroughs have been engaged in the process of bidding for this prestigious status for some years. In his talk, Graham Worton recounted his experiences at the most recent event in the long sequence of submissions, presentations and events which have been his responsibility as Chair of the Black Country Geopark Project Management Team. This recent event was the 7th International Conference on Global Geoparks, held in the English Riviera Global Geopark in September. Graham came away from this meeting with cautious optimism, and the knowledge that the final decision of the Unesco Global Geoparks Council will be announced in Spring 2017. BCGS will welcome a positive outcome, and the chance to establish a new focus for geology in the Black Country after the imminent closure of Dudley Museum and Art Gallery. ■

Julie Schroder

Spotlight on the 'Great Stone' in Northfield

We advertised the plaque unveiling ceremony in the last issue of our Newsletter, (issue 239, p4) and it took place on Saturday 8 October. The pound beside the Great Stone Inn in Northfield was packed and overflowing with local residents and dignitaries, plus several members of BCGS. Below we present Roland's account of the event (see front cover photo: Roland addressing the assembled company). Roland's account is followed by Rob Ixer's analysis of the Great Stone's composition. Ed.

How a Large Chunk of Rock was Honoured

Recently over a hundred people crammed into the 17th century stray animal pound in Northfield old town in Birmingham. Why would they do that? They had come to see the unveiling of a plaque in honour of a glacial boulder. The boulder, locally well known as the Great Stone, had given its name to the adjacent inn and to a nearby road. It had stood for 62 years, visible, protected, but also beyond reach and touch, behind the gate and railings of the pound. ►

Roland celebrates the culmination of his 'Great Stone' project

The Great Stone was only remembered for its former position in the roadway, protecting the corner wall of the inn from passing wagons. The feet of generations of children going to and from the nearby church school had polished the raised surfaces on top of the boulder. Local residents had wondered whether the hidden part of the boulder actually formed part of the inn's foundations. It had become a familiar and cherished object. However, the Committee of the City Public Works Department had road safety concerns. They wanted to remove the stone, but such was the local opposition that the committee consulted the Professor of Geology at the University of Birmingham, Professor Shotton. The outcome was that the stone was preserved. Press cuttings from 1954 depicting the actual moving of the stone can be seen in the inn.

I had long thought that the Great Stone deserved to be brought back to public notice and that a descriptive plaque would help. There had never been one. I had also come to realise that the Great Stone was not alone and that there were dozens of large boulders visible all over South Birmingham but standing incognito so that passers-by never gave them a second glance. I considered that suitable wording on the plaque would raise public awareness of the other boulders also. That this proved correct was shown by the speed with which my pamphlets showing the location of other glacial boulders were taken at the unveiling of the plaque. The Great Stone in the pound beside the Great Stone Inn also seemed to be an ideal place to terminate a glacial boulder walking trail. I have developed this trail over three and a half miles from the great boulder on the University of Birmingham campus, through Selly Oak and Bournville meeting several boulders along the way. I am hoping that a trail pamphlet will be adopted by the Lapworth Museum.

The actual unveiling of the plaque was performed on Saturday 8 October by Dr Rob Ixer. Members will remember that he came to one of our meetings earlier this year and talked about his work on the Blue Stones at Stonehenge. Who better to do some work on the Great Stone at Northfield? He readily agreed to do this and from a fragment of the stone he produced a detailed report *(see below).* Rob's speech at the unveiling was very well received and he astonished many when he described the journey of the Great Stone not just from Snowdonia by the power of moving ice but also from the South Atlantic region of the globe by tectonic forces. Three local councillors came to the unveiling and stressed the importance of identifying and preserving our heritage both historical and natural.

The plaque itself, white on blue to match an existing plaque describing the pound, was made by Leander Architectural of Buxton. I am grateful to John Gale of the Birmingham Civic Society for his friendly support of the project and his advice concerning the plaque. He also supplied the curtains for Rob to pull open to reveal the plaque. Julie Schroder has enthusiastically backed my efforts to bring the project to a conclusion and I very much appreciate the committee of the BCGS for their financial contribution towards the cost. ■

Roland L Kedge

The plaque unveiled

The Great Stone analysed

The Great Stone is an altered vitric-crystal-lithic tuff belonging to the Ordovician Snowdon Volcanic Group cropping out extensively in Snowdonia, North Wales.

Macroscopical Description

Sample

The outer, weathered surface varies in colour from a yellowish-grey to a greyish-olive (5Y 7/2 - 10Y 5/2 on the Geological Society of America rock-colour chart) but is a light brown (5YR 6/4) where limonite-stained. The surface has small pits and so is slightly vuggy.

The cut surface has a 2.0mm thick, pale yellowish-brown (10YR 6/2), outer margin above a 4.0mm thick, light grey (N7) zone, but the interior of the rock is a light bluish-grey (5B 6/1) and is slightly mottled with very thin, cross-cutting veinlets. Irregular vughs, often limonite-stained, are 2.0 - 3.0mm in size and many have pale-coloured feldspar within them.

Thin section

The rock is a very light greenish-grey with an irregular, 2.0 - 3.0mm thick, limonite-rich rim. The majority of sherds are indistinct but rare dark clasts, 1.0 - 1.5mm in diameter, have sharp junctions. A single 'microtonalite' clast is 1.0mm long and tabular pumice clasts are 1.0 - 2.5mm in length. The rock has a very poorly defined planar fabric with layers centimetres by millimetres in size.

Rob Ixer tells the story of the Great Stone

Microscopical Description

Large feldspar crystals, vitric and lithic clasts are present within a fine-grained but crystalline quartz-albite-chlorite-muscovite groundmass. The rock has been limonitically stained and is extensively recrystallised.

Single and polycrystalline feldspar aggregates comprise untwinned and simply twinned and more rarely polysynthetically twinned feldspars that show incipient alteration along grain boundaries and cleavage plane to fine-grained white mica. Zoning and overgrowths are poorly developed and much feldspar has been plucked from the slide. Accessory minerals: mainly acicular and stubby apatite, euhedral to rounded zircon but also equant, altered iron titanium oxides are enclosed within the feldspars and concentrated along their margins.

Tabular, longitudinal sections through tube pumice sherds have sharp edges and now comprise aligned quartz and chlorite; other areas with sub-spheroidal textures between quartz and chlorite are transverse sections through tube pumice. Other common clasts are very vesicular but have been recrystallised. Less common are sedimentary-like sherds with aligned quartz-chlorite; some carry small amounts of apatite and zircon (so may be igneous rather than sedimentary). Rare clasts include 'microtonalite' comprising abundant thin, pale brown, acicular feldspar laths in random orientations. The bent fabric of some sherds shows they were soft when deposited and deformed. ►

Vesicles within vesicular clasts are progressively infilled by a muscovite or chlorite rim and a quartz core. Locally, euhedral, pale brown to colourless, faintly pleochroic tourmaline accompanies the quartz. Glass sherds are elongate but more often highly cuspate and zoned with dusty zones following the outline of the sherd. They are replaced by quartz with grain boundaries that do not reflect the original sherd shape.

The main matrix comprises fine-grained quartz-albite-chlorite and muscovite intergrowths; much albite shows abundant twinning. Slightly coarser grained recrystallised patches form quartz-albite-muscovite-rich areas. Rare zircon and broken apatite and chlorite-rich patches are present in the matrix. Very, very small opaques are cubic in shape.

Remarks

Comparisons between the petrography of this lithic with those from a number of horizons within the Snowdon Volcanic Group of North Wales shows them to be very similar. It is unlikely that a more specific geographical origin will be determined. ■

Rob Ixer, March 2016

Three Building Stones trails for Birmingham

Work has been in progress for some time to produce a series of building stones trails worthy of the nation's Second City, and I am pleased to bring you news that the first of these, 'From the Town Hall to the Cathedral' is now completed and available on our web site here: http://bcgs.info/pub/local-geology/building-stone-trails/ It can be downloaded as a pdf, or viewed in a web-based format with additional information and photos. The web version has been designed with mobile phones in mind.

Background


Frosterley Marble at 122-124 Colmore Row

Soon after I became Newsletter Editor several years ago, I became interested in the idea of building stones trails for Birmingham and the Black Country after I received some notes and diagrams from Eric Robinson. These were for a short Building Stones trail around Birmingham City Centre which he had done for a conference in 1999. Eric now lives in Somerset, but had connections with BCGS long ago. He has had a long and distinguished career in geology, teaching at UCL for many years and is passionate about the value of building stones as an aid to teaching geology.

During the redevelopment of the Lapworth Museum in 2015, an opportunity arose to bring building stones into the public realm during the Lapworth's temporary 'Stones and Bones' exhibition at the Library of Birmingham. In liaison with the Lapworth team and my husband John, (BCGS webmaster), an A4 sized 'Building Stones Detective Trail' leaflet was produced as an extension to the exhibition. It was based on Eric Robinson's trail with his permission and encouragement, and was available for the duration of the exhibition.

Afterwards, we were eager to pursue the possibility of using this as a starting point for a comprehensive building stones trail for Birmingham. Then in October 2015 I was fortunate to meet Ruth Siddall. Ruth, like Eric before her, works at UCL and is also passionate about building stones, ►

having produced numerous London-based trails. These can be seen and downloaded from her web site: http://www.ucl.ac.uk/~ucfbrxs/Homepage/UrbanGeology.

As a former student at the University of Birmingham, Ruth warmed to the idea of this project, and we joined forces earlier this year, along with former Birmingham geology student Laura Hamilton, to do the 'field work' taking loads of photos and copious notes. It quickly became apparent that there was too much for one trail, and it was decided to do three under the broad title 'Building Birmingham'.

'Building Birmingham' - the project so far and the next step

The BCGS committee agreed to become involved, and Ruth was happy to produce the detailed trails as pdfs for BCGS. John Schroder had volunteered to produce web-based versions of the trails for the BCGS web site, and it was agreed that the next step would be to reduce and simplify the text with a view to publication as free leaflets.

With feedback from those involved, Ruth has now completed the first two trails, and both are available to download from her Urban Geology web site. John has so far completed the web version of the first trail, available on our web site as detailed above. We will keep you informed as the project progresses, and would appreciate your involvement. The great value of the web site is that nothing has to be 'cast in stone'. Please let John or me know if you find any mistakes, inaccuracies or information which you think we should add, or if you have any other comments, using my address: newsletter@bcgs.info

It remains just to thank Ruth Siddall for the enormous amount of time and effort she has put into this project. We are very grateful to her for sharing her expertise to produce these fantastic trails. ■

Julie Schroder

The Wren's Nest 60th Anniversary Celebration

This event was held on Wednesday 21 September in the Harty Building, at the rear of the former Mons Hill College Campus, organised by the Friends of Wren's Nest National Nature Reserve, and the Reserve wardens. Attendees including staff from Dudley Council, Natural England, the Friends Group and the BCGS met at around 10.00 for refreshments prior to the day's events beginning at 10.30.

The day started with an introduction from Elaine Bouckley (Friends Group) and this was followed by a talk from Rob Broadbent (Friends Group). The talk was entitled 'The Jewel of Dudley' and covered the importance of the Wren's Nest Nature Reserve, its history and that of Dudley, the landscape and topography, flora and fauna, the industrial heritage and mine workings, the geology, and Sir Roderick Impey Murchison - the King of Siluria.

After Rob's talk, Elaine opened the floor to Graham Worton and Professor Richard Fortey (world expert on trilobites). Professor Fortey started by talking about the Wren's Nest and trilobites and Graham followed with more information about the reserve and details concerning the UNESCO bid for the Black Country Global Geopark. Afterwards there was a short question and answer session about the reserve. Following a buffet lunch, with the food kindly provided by Tesco, attendees could either join a guided walk around the reserve or assist with a 'geo-blitz' of the main patch reef to collect, identify and compare those fossils found on the reef with those found on the seabed.

The day's activities finished around 3.00 with remaining attendees sheltering in the warden's offices out of the rain. ■

Andy Harrison

Field Meeting Report

Saturday 10 September: Titterstone Clee Hill. Led by Andrew Jenkinson.

Introduction.

This was a joint field meeting with the Shropshire Geological Society, led by Andrew Jenkinson. The weather forecasters had indicated that the rain would clear early, suggesting the prospect of fine views to appreciate the geomorphology of the surrounding countryside. Andrew opened the session with an introduction to the general geology and local stratigraphy using the Geological Survey maps of the surrounding area. The weather, however, had other ideas and the steady wet murk gave us a commanding view to the fence of the car park and very little further! The programme therefore was curtailed to those areas that could safely be examined under the prevailing conditions.

Stratigraphy

The simplified succession is as follows:

Glacial deposits	Head and till	Quaternary
Unconformity		
Coal Measures (Kinlet Series)	Grey and yellow clays with fine sandstones and coal seams	Late Carboniferous (Westphalian C). (Moscovian)
Intrusive Dolerite Sill	Olivine-Dolerite	
Kinlet Series	Grey and yellow clays with fine sandstones and coal seams	
Unconformity		
Cornbrook Sandstones	Coarse yellow felspathic sandstones and conglomerates	Namurian (Serpukovian)
Carboniferous Limestones	Studley, Gorstley, Oreton, Farlow Limestones	Tournasian
Uncomformity		
Farlow Series	Conglomerates and mudstones	Devonian Upper Old Red Sandstone
Clee Group	Sandstones, mudstones and conglomerates	Lower Old Red Sandstone
Ditton Series	Mudstones, sandstones conglomeratic cornstones	Lower Old Red Sandstone
Downton Series	Mudstones and siltstones	Upper Silurian (Přídolí)

Palaeogeography

During the Carboniferous a slowly subsiding ‘block’ known as the ‘Wales-London-Brabant Massif’ (formerly referred to as ‘St George's Land’) separated the Midlands and the North from Wales and Southern England. There were marked differences in sedimentation sequences either side of this barrier during the Dinantian (Mississipian) Epoch, Tournasian Age when the Carboniferous limestones were being laid down. To the north of the massif there are marked unconformities on older rocks. For example, in the Ingleton area, they rest directly on steeply dipping Silurian slates. ►

In the southern area there is generally a conformable passage from the upper Devonian into the marine Carboniferous depositions (Toghill, 2000, p105)[1] that would seem to indicate the gradual marine transgression of a warm shallow sub-tropical sea, although locally at Clee Hill, the limestones begin with a basal conglomerate that is unconformable on the Farlow Series of the Devonian Upper Old Red Sandstone.

Titterstone Clee Hill forms the northernmost occurrence of the South Western Province Carboniferous Limestones. The basal beds are the lowest Dinantian (Mississippian) shales which are Courceyan in age (363 Ma). These are followed by Chadian Stage limestones up to 50 metres in thickness. No further Dinantian (Mississippian) stages occur and the rocks pass upwards into Millstone Grit type sandstones and the Productive Coal Measures.

It has been suggested (Toghill, 2000, p108)[1] that this formed the southern boundary of the Wales-London-Brabant Massif as there are no Carboniferous Limestones further to the north on Brown Clee Hill. Here the Coal Measures are deposited directly on the Old Red Sandstones. The seas may have covered the Massif at some time with the sediments subsequently being eroded prior to the deposition of the Coal Measures. This would be contemporaneous with the Sudetic earth movements of the mid-Carboniferous during one of the closure phases of the Rheic Ocean.

The 200 metres thickness of the Millstone Grit type sandstones on Titterstone Clee Hill is also considered to be the northernmost example of these rocks in the South Western Province. These sandstones were designated as the Cornbrook Sandstones by E.E.L. Dixon in 1917 (Geological Survey Memoirs Sheet 166, 1968, p249).[2] Dixon held the view that they were conformable with the underlying Carboniferous Limestone, but that they were older than the true Millstone Grits. He gave them an age of Lower Carboniferous (Upper Avonian). Pollen found in the sandstones dates them to the early Namurian (Serpukhovian). They are unconformable on the underlying Carboniferous Limestones and Devonian strata (Toghill, 2006, p173).[3]

These sandstones represent the rapid erosion of the Massif and the formation of deltaic sandstones deposited by rivers running off the landmass. This was followed by the deposition of siltstones and mudstones allowing the formation of coastal swamps. On these delta flats, thick layers of peat were laid down by the luxuriant tropical forests that colonized the delta platforms. Subsequent subsidence of the basin caused marine transgressions to deposit further sediments on top of these peat beds, interrupting peat deposition. Conditions then returned to a brackish or freshwater environment with fine muds and silts laid down again until the platforms were re-established allowing the cycle to repeat. Compression of the sediments by up to 80% turned the peat into coal. This cyclic depositional sequence is termed a cyclothem.

Fig.1 Dolerite sill with Coal Measures above and the darker contact zone visible. (Photo taken on a previous field visit when the sun was actually shining!)

Locality 1 (SO 596756) *Ordnance Survey 1:50,000 Sheet 138, Kidderminster and Wyre Forest*

A steady walk uphill past the (now closed) Kremlin Public House, took us across the track bed of the former standard gauge railway line that ran between the quarries and the head of the tramway. On reaching the viewpoint of the now flooded Incline ►

Quarry, the scale of the quarrying was immediately apparent. Here the dolerite sill of some 60 metres thickness is well exposed and the upper contact with the overlying Coal Measures of the Kinlet Series (Fig.1) can be seen along with rudimentary columnar jointing, though the lower contact is not visible.

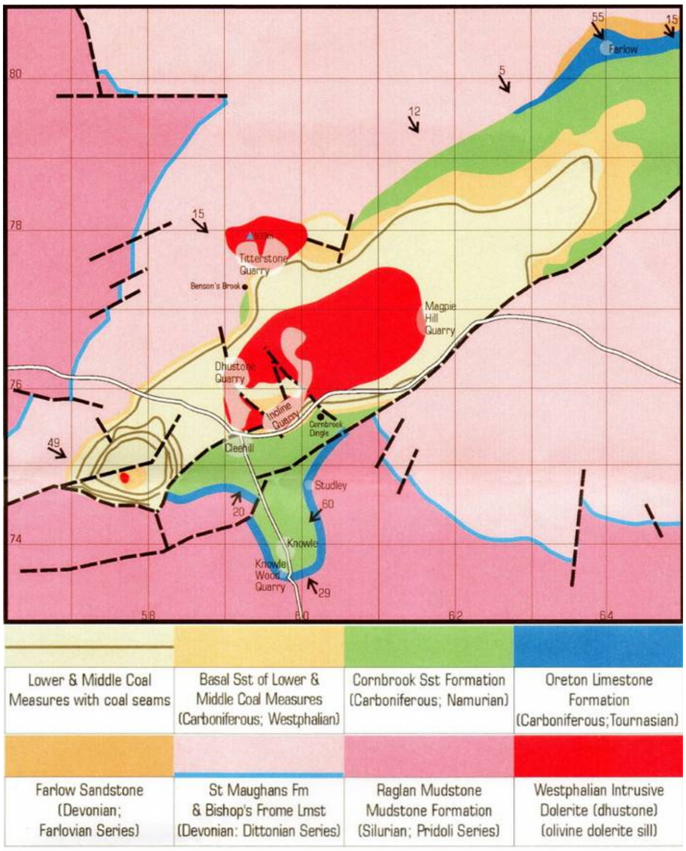
The olivine-dolerite is known locally as Dhustone (derived from the Welsh Language (ddu = black) and meaning ‘black stone'. It was used extensively by the Victorians for stone pavement sets in Ludlow and other towns. Dolerite is a heavy blue-black coloured, medium-grained basic igneous rock and is found in small and medium scale igneous structures such as sills, dykes, laccoliths and volcanic necks. It consists of olivine ($(Mg,Fe,Mn,Ca)_2\ SiO_4$) and pyroxene ($(Mg,Fe)Si_2O_6$) with some feldspar and mica (Dixon, D., 1992, p96).[4] Some dolerites exhibit a greenish tinge due to the presence of serpentine as a breakdown product of the olivine. Sills will be found with thermal contact metamorphic rocks above and below and are usually intruded horizontally, but may be folded later so that in field exposures they can occur at any angle. The magnesium-iron minerals in it, particularly the olivine, are subject to chemical alteration by the weather and an exposed dolerite will erode quickly to form flaky, spheroidal forms (Onion Skin Weathering).

The synclinal form of the hilltop could be seen, as both Titterstone Clee and Brown Clee are synclines that form the highest ground, separated by the axis of the Ludlow Anticline, all trending NE/SW, and showing the overall Caledonide trend for the dominant folding. Andrew explained that the somewhat perverse form of synclines in the hill tops and anticlines in the valley between was due to differential erosion rates. Anticlines form extensional stress fractures and lines of weakness that permit faster weathering, whilst the compressive forces in the axes of the synclines compact the rocks making them more resistant to erosion. The hardness of the dolerite then protects the softer rocks in the syncline floor from glacial scour and they end up on the hill tops.

Locality 2 (SO 601760)

The topography reveals open rough grass and gorse moorland crossed by a small stream with broken ground and many tip and spoil areas visible. These are the coal measures that underlie the sill and demonstrate that the sill was indeed intruded between Coal Measure sediments comprising sandstones, shales and thin coal seams.

The Clee Hills Coalfield is in the Lower and Middle Coal Measures and the worked seams include the Gutter Coal, Four Foot Coal, Smith Coal, Three Quarter Coal and the Great Coal (Toghill, 2006, p182).[3] The earliest coal mining was carried out using the Bell Pit method to provide coal mainly for local lime burners, and traces of old pits are to be found both above and below the dolerite intrusion. The lime was quarried a little further down the hill from an exposure of the underlying Oreton Limestone (Carboniferous Period, Mississippian Epoch, Tournasian Age). ►



Map 2: Geological map of the Titterstone Clee Hill Carboniferous Outlier, derived from the BGS Ludlow Sheet 181

Fig. 2 Local Geology Map Extract

Locality 3 (SO 603761)

This comprised somewhat larger spoil mounds that were part of the former early Cornbrook Coalfield. Technology was introduced underground and proper collieries were developed, with steam power to allow deeper working. Drainage adits were driven to dewater the workings into the Corn Brook and elsewhere. By the 1840s, there were about 250 miners producing an average of 25,000 tons of coal per year. In an attempt to ease transport of coal off the hill, a railway was built to Ludlow in the mid-1860s. This reached the top of the hill by a rope-worked incline. By this time, however, the coalfield had passed its peak and the mines of Lewis and Botfield passed to a series of small private companies. There was a brief revival during the Second World War for local use but all working had ceased by 1945, (Shropshire History Web Site). The area is well grassed over and the only exposure of the mine spoil is courtesy of the local rabbit population. They say that the proof of the pudding is in the eating and the existence of coal pit spoil was proved when one lucky SGS member was rewarded with a nice fossil of *Stigmaria ficoides*, a fossilized root section from an arborescent Lycopsid plant.

Locality 4 (SO 593775)

After returning to the car park for lunch (as the local hostelries all appeared to have closed down) the afternoon session commenced with a short car journey to Titterstone Quarry which lies to the north of the Clee Hill and Dhustone quarries. The car parking area at the top of the access road provided a commanding view of the quarry and by now an easing of the weather enabled the topography to be viewed to the south and west towards Ludlow and the Welsh Marches.

Immediately below the viewpoint is another area of broken ground and bell pit spoil heaps that mark more of the coal measures overlying the intrusion and forming part of a discrete circular outcrop that can be seen in the SW corner on the geological map extract that Andrew kindly provided (Fig. 2). This area was intensively mined before the extraction of the dolerite commenced and large volumes of quarry spoil have been tipped on top of this ground. The remains of the old crushing mills and the tramway are still very evident between the car park and the spoil heaps.

Locality 5 (SO 597777)

This offered a viewpoint to the east into the old quarry workings below the present day NATS radar installations (the ‘giant golfballs’ that are visible even from Dudley). The vertical and horizontal jointing here is more marked (Fig. 3) and indicates why the stone was so sought after for the production and dressing of the road sets that are evident in many local towns.

Fig. 3 Jointing in dolerite in old Titterstone Quarry

Within the quarry floor approaches there are the remains of the wooden track bed sleepers that formed part of the old railway sidings serving the operation. Andrew showed us a photograph (Fig. 4) from a publication by Field and Mackay Ltd., that shows these sidings in place at the No.1 face of the Titterstone Quarry during the early 20th Century. The photo is captioned as the 'Funnel of Eruption' though this is not the case, as this is an intrusive sill that would have been emplaced laterally into the unlithified sediments. However, there must be a feeder pipe somewhere, as yet not found. ►

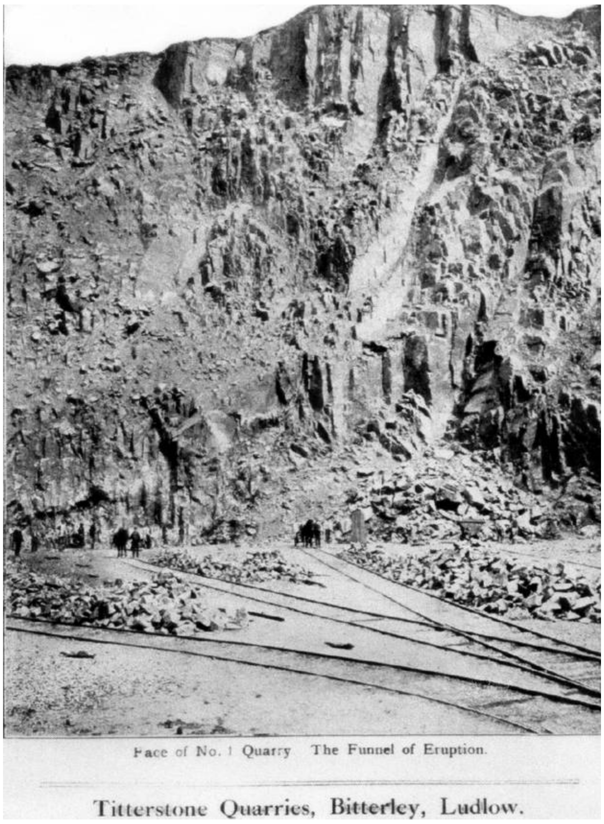


Fig. 4 Titterstone Quarry, No.1 face, early 1900s

Locality 6 (SO 594765)

A short car journey to the southwest placed us at the viewing point over the present day operational Clee Hill Quarry, operated by Hanson Aggregates Ltd. They extract and crush the rock for road metal both 'dry' and bitumen coated, the production of road sets having been consigned to the pages of history. An information sheet issued by the quarry operators describes the Dhustone dolerite as 'fine-grained, consisting of olivine phenocrysts set in a groundmass of plagioclase feldspars (labradorite-bytownite) with augite pyroxene and minor magnetite and rutile. Analcite may occasionally be found interstitially in the freshest dolerite. Olivine shows complete to partial serpentinisation whilst plagioclase may be albitised and replaced by carbonate'.[5]

From here is a commanding view to the south (Fig. 5) that shows the present extent of the working of the dolerite sill and the overlying Kinlet Series of the Westphalian C (Moscovian) Coal Measures.

The Dhustone Clee Hill quarry is now the only working quarry left. Specific planning consents for quarrying were issued in 1947, the first covering an area of 251 hectares. By the late 1970s all the remaining planned reserves of dolerite were overlain by an overburden of Coal Measures and glacial deposits. The Coal Measures included four recognized coal seams that had previously been mined by the Bell Pit method. An evaluation of the coal deposits was made in the 1980s which established the economic viability of opencasting the coal seams. A new consent was issued in 1988 and by 1992 some 320,000 tonnes of coal was mined and 2.5 million cubic metres of overburden was removed and used to backfill and landscape the former Belfry Quarry. This exposed extensive reserves of high quality dolerite ensuring the long term viability of the quarry. The site blasts once or twice a month on average and the crushed and graded material is used for dry and coated aggregates, rock armour for sea and river defence works, gabion stone for ground stabilisation, rail ballast and raw material for insulation products. ►

Fig. 5 Looking from the viewpoint on Titterstone Clee Hill over the current working quarry

According to Kelling and Collinson (1992, p253)[6] increased tectonic activity during latest Westphlalian C was marked by the intrusion of dolerites into the West Midlands at Rowley Regis and Wednesfield. They refer to work carried out by Kirton (1984)[7] which involved radiometric dating of the dolerite sills of the West Midlands. Assuming the Clee Hill dolerite is contemporaneous, this work puts emplacement of these sills at 295Ma which would age it at Westphalian D, but, it is considered to have been intruded into ductile unconsolidated Westphalian C Coal Measures, prior to or during folding. More recent radiometric dating has now indicated an age of c.300Ma that places this intrusion in the late Carboniferous Stephanian age (Toghill, 2006, p184).[3] The sill is probably composite with two main intrusions (Fig. 6).

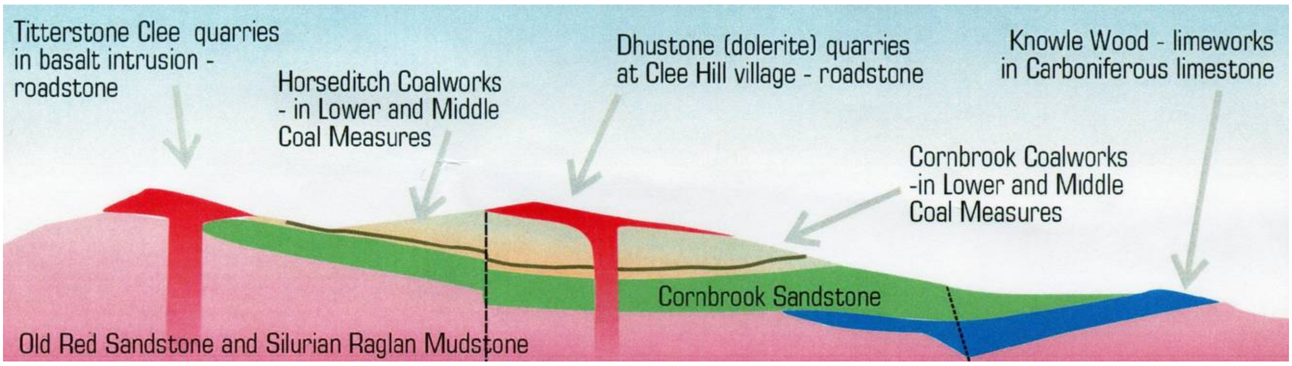


Fig. 6 Composite nature of the dolerite sill intrusions at Titterstone Clee Hill

Locality 7 (SO 622778)

This was our final stop for the day at Farlow on the edge of Catherton Common. This was again a former coal mining area that lies at the north-eastern end of the fold axis and comprises the lower part of the Westphalian C (Moscovian) Coal Measures that are exposed in this area. The old spoil heaps are again evident but the remains of the mines, cableways and tramways are now gone. There are views to the north-east across the underlying Namurian (Bashkirian) age Cornbrook Sandstone to the wooded outcrop of the Tournasian age Oreton Limestone. The area is now a publicly accessible SSSI with a wide range of specialised plants that have colonised the site.

Andrew was thanked for his time and effort, making an interesting and rewarding day despite the best efforts of the British weather to scupper the proceedings. ■

Bob Bucki

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Mike's Musings No. 6 - Geology and Colour Part 1

Much of geology often seems to consist of variations on the colour grey, ranging from the extremes of off-white all the way through to black. This includes many commonly occurring rocks such as chalk, limestone, mudstone, shale, coal, (pure) marble and basalt. Can geology really be so dull? Well, of course not. And once you begin looking for colour, it's all over the place, though it must perhaps be admitted that the living world generally offers colour in greater exuberance than the lifeless world of mineral, rock and fossil.

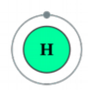
What is Colour?

Colour is a sensation which our brains are designed to process from the electromagnetic radiation of the visible spectrum falling upon sensors within the eye (the retina, consisting of so-called colour photoreceptors or 'cones' and the far more numerous 'rods' which process black and white only). This sensation depends on the light wavelengths they receive from the objects around us. This in turn depends on the nature of the light particles (photons) coming from such objects. And this in turn can only be explained at the deepest level by delving into the unfathomable (to most of us, myself included) depths of quantum physics. However, there are some simplistic observations that can help to explain some of the 'whys' that we shall encounter in what follows.

In less rigorous terms, colour may be regarded as being produced in one of four ways:

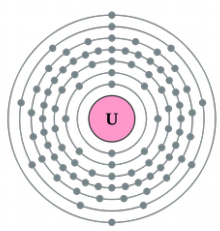
1) a light source only emitting part of the visible spectrum (as in atomic spectra)
2) an object only absorbing part of any incident white light (as in dyes/pigments/minerals)
3) by the scattering, diffraction or dispersal of white light (due to the structure of an object)
4) by physiological means (tired eyes, rubbing your eyes etc.)

A good starting point for colour in the geological world probably begins with the mineral kingdom. The colour we find in minerals can be explained in terms of either their chemical composition or aspects of their physical structure at the atomic level (usually due to any impurities or imperfections they might contain). Returning to the quantum world, it may help to envisage the simple model of an atom in which electrons orbit around a nucleus of combined protons and neutrons.



hydrogen

It is the electrons that are most important in relation to colour. Every element has a unique atomic structure which gets more complicated as the size of the atom increases (i.e. moving up the Periodic Table of naturally occurring elements from hydrogen, element no. 1, to uranium, element no. 92). In this progression, the number of electrons present increases, being accommodated in an increasing number of 'atomic shells', each shell having a particluar 'energy level'. Any particular shell is able to accommodate a specific number of electrons; therefore shells may either be completely filled, or only partially full. This influences the mobility of the electrons concerned.



uranium

When white light interacts with the electron configuration of any element it can excite some of the electrons, inducing them to move to a higher energy level. The wavelengths that cause this are subtracted from the white light, which creates the effect of colour. Different atoms create different colour effects. ►

This helps to explain why larger atoms, in general, are more likely to produce the effects of colour; they have more electron shells, with greater potential to produce light photons within the visible range. Moreover, smaller atoms often link together with strong, stable bonds forming compounds that are unable to absorb any parts of the visible spectrum, and so appear colourless.

Minerals and Colour

Ametrine, varity of quartz, comprising Amethyst and Citrine from Bolivia, Wikimedia Commons

Returning to the world of minerals, we can now make a start with quartz. For the very reason just explained, quartz, when pure, is colourless. It consists of simple combinations of silicon and oxygen atoms bound strongly together. However, if impurities are present, quartz is often coloured. Thus we find that amethyst contains iron atoms (often damaged by gamma radiation) which create the purple colour. If amethyst is heated, the electrons in the iron atoms become agitated in such a way as to appear yellowish, producing the variety we call citrine. Amethyst and citrine may occur naturally in a single crystal producing the rare variety ametrine, which is both yellowish and purple reflecting a temperature gradient during its formation. Heating still further produces a variety of green quartz which doesn't appear to have a name! Chrysoprase, an apple-green variety of chalcedony (itself a form of quartz), is green for a different reason, the presence of nickel impurity.

Incidentally, the heating effect alluded to above also explains why hot objects often begin to glow: the heating element of a fire or electric cooker are obvious examples. This electron excitability is most readily perceived in the geological world as molten lava, with the colour of the glow varying with temperature, and, to a lesser extent, chemical composition.

Halite, or 'table salt' consists simply of sodium and chlorine in combination (NaCl), and is like quartz, colourless when pure. Physical effects make it appear white in the salt cellar only because we see it mainly as an aggregate of finely divided particles; sea-salt has larger particles and consequently the colourless character is more apparent.

Back with quartz, the variety 'Cairngorm' or 'smoky quartz' is caused by radiation damaged aluminium atoms replacing some of the silicon atoms. Rose quartz has been explained variously as impurities of iron, titanium and/or manganese or lithium, or as inclusions of a complex alumino-boro-silicate mineral called dumortierite.

A sample of Mike's sand collection

Blue or bluish quartz may be the result of either inclusions of ilmenite (titanium dioxide) or the deformation effects of metamorphism straining the atomic lattice structure such that white light striking it is absorbed differently. Milky quartz occurs due to inclusions of gas or air bubbles, and thus also results from a physical effect, by dispersing light to create the whitish colour. ►

The chemists amongst you may have noted that several of the impurities mentioned above are 'transition metal elements'. These elements are all examples of larger atoms, and it is the so-called '3d' shell of electrons that are particlularly good at absorbing light, with just the right energy to leave behind light wavelengths falling within the visible spectrum. Cobalt, chromium and copper are further transition metals that we shall hear of again. The last two are a little different from the rest because they have a single, unpaired electron in the higher '4s' shell as well as unfilled '3d' shells. ■

Mike Allen

In the second part of this article we shall explore further qualitative examples of what gives minerals and rocks their colour (without further exploration of the physics that lies behind).

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