Newsletter No. 257
October 2019

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Copy date for the next Newsletter is Sunday 1 December

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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, Twitter: @BCGeoSoc and Facebook.

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.

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.

Monday 21 October *(Indoor Meeting):* 'A Geological Grand Tour of the Solar System'. Speaker: Andrew Lound. A tour of the solar system taking us on a journey from the sun to the far outreaches of the solar system, along the way visiting planets, moons, asteroids and comets. Illustrated with the very latest images and supplemented by music.

Saturday 16 November *(Field Meeting):* An Introduction to Castle Hill. Led by Ian Beech (Wren's Nest Nature Reserve). Meet at 10.00 in the Wren's Nest wardens' office, Fossil View, off Wren's Hill Road, Dudley, DY1 3SB. After tea/coffee, walk from the wardens' base to Castle Hill via Bluebell Wood. We will be visiting managed and unmanaged sites, looking at outcrops and logging areas with any findings. Many of the outcrops are similar to Wren's Nest so we should be able to make a comparison along with a general introduction to the site. (Note: This event has been moved from Saturday 17 August).

Monday 18 November *(Indoor Meeting):* Talk details TBC.

Saturday 7 December *(Geoconservation Day):* Barrow Hill. Directed by the Barrow Hill LNR warden. Meet on Vicarage Lane off High Street, Pensnett (A4101), at the top end near to the nature reserve and St. Marks Church, at 10.30. The day will involve vegetation clearance in the East Quarry. Wear old clothing and stout boots or wellies. Please bring gloves and tools if you can, i.e. brushes, trowels, loppers, saws, rakes etc. Safety glasses and hard hats will be provided where necessary. Bring a packed lunch and hot drink. We will aim to finish around 2.30.

Monday 16 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 Keith Elder if you can contribute to this event: meetingsecretary@bcgs.info

Saturday 18 January 2020 *(Geoconservation Day):* Wren's Nest. Directed by the Reserve wardens. Meet at 10.30 at the Warden's office, at the end of Fossil View (the road into the new housing estate, formerly Mons Hill College). Parking along Fossil View. The day will involve some scrub clearance and fossil hunting not far from the Warden's base. Bring gloves, stout footwear and packed lunch. Wardens will provide tools, hard hats if necessary and a hot drink. Finish around 2.30.

Monday 20 January *(Indoor Meeting):* 'Jurassic Brain Teasers'. Speaker: Stephan Lautenschlager (Lecturer in Palaeobiology, University of Birmingham). Fossils represent physical evidence for the existence of extinct organisms and have vast potential for the study of ancient life. However, the majority of fossils are preserved in the form of hard-tissues (e.g. bones and teeth), while soft-tissues, such as muscles and internal organs, have withered away. Using modern computer technology and digital visualisation techniques, it is now possible to reconstruct some of these soft-tissues in fossils. The anatomy of the brain is of particular interest, as it can reveal information about extinct animals' behaviours and how they might have sensed the environment around them.

Saturday 8 February *(Geoconservation Day):* Saltwells Local Nature Reserve. Meet at the Nature Reserve car park (Grid ref: SJ 934 868) on Saltwells Lane at 10.30. Wear old work clothes, waterproofs and stout footwear or wellies. Please bring gloves and garden tools (hand brushes, trowels, loppers, secateurs, forks and spades if you have them). Either bring packed lunch or hot food can be acquired from the Saltwells Inn adjacent to the car park. Finish at 2.30.

Monday 17 February *(Indoor Meeting):* 'The Impacts of Future Climate Change on Industrial Landscapes: recent work in The Derwent Valley Mills WHS and its relevance to the Black Country'. Speaker: Dr Andy J. Howard ('Landscape Research & Management', and Honorary Fellow, Dept. of Archaeology, University of Durham). The availability of coal, limestone and metal ores together with water for power, was critical to the development of the heavy industries that kindled the Industrial Revolution. Paradoxically, many of these advantageous characteristics, also create environments where geomorphological processes are most sensitive to future climatic and environmental change. This talk by Dr Andy Howard describes a 'landscape' approach developed to manage the built and other historic assets of the Derwent Valley Mills World Heritage Site along the River Derwent between Matlock Bath and Derby. As we move forward into the Anthropocene, the applicability of this study to other industrial landscapes such as that of the Black Country is considered.

Saturday 7 March *(Geoconservation Day):* Barrow Hill. Directed by the reserve warden. Meet on Vicarage Lane off High Street, Pensnett (A4101), at the top end near to the nature reserve and the church (St. Marks), for a 10.30 start. The day will involve vegetation clearance in the East Quarry. Wear old clothing and stout boots or wellies. Please bring gloves and tools; i.e. brushes, trowels, loppers, saws, rakes etc. Safety glasses and hard hats will be provided where necessary. Bring a packed lunch and hot drink. We will aim to finish around 2.30.

Monday 16 March *(Indoor Meeting, 7.00 for 7.30 start):* AGM followed by a talk TBC.

Monday 20 April *(Indoor Meeting):* 'Silurian Rocks of the Dingle Peninsula'. Speaker: Ken Higgs, Emeritus Professor of Geology, University College Cork. Dudley and the Dingle Peninsula in Eire have much in common, sharing a common Silurian geology. Professor Ken Higgs was not only born in Dudley but has also undertaken an extensive study of the geology of the Dingle Peninsula recently published as the 'Geology of the Dingle Peninsula' by the Geological Survey of Ireland. His illustrated talk will describe the Dingle Peninsula's dramatic 485 million year history of environmental and climate change.

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 websites.

Mid Wales Geology Club

Wednesday 16 October: A night of Minerals with Bill Bagley and Michele Becker.

Further information: Tony Thorp tel. 01686 624820 and 622517 tonydolfor@gmail.com
Web: http://midwalesgeology.org.uk Talks at 7.30 at Plas Dolerw, Milford Road, Newtown.

The Geologists' Association Annual Conference 2019
Geological Resources in the North West - Past, Present & Future

Friday 18 - Sunday 20 October at University of Manchester and Manchester Museum

Programme:

Friday 18 October: Arrival & Registration. Plus a visit to Manchester Museum's Minerals & Palaeontology section.

Saturday 19 October: Talks and Posters at Manchester University campus followed by evening Conference Dinner.

Sunday 20 October: Field Trips.

For further information and registration visit: www.geologistsassociation.org.uk
or email: conference@geologistsassociation.org.uk

Hosted by the geological groups of Lancashire, Liverpool, Manchester, North Staffordshire & North Wales.

The Geologists' Association Festival of Geology
Saturday 2 & Sunday 3 November

For everyone interested in Earth and its Origins. Children and families welcome.

Saturday 2 November 1.30 - 4.30 at UCL. Free Event.

Talks - Exhibits - Rocks and fossils for sale - Tour of UCL's Geology labs - Activities for children.

Sunday 3 November Festival Field Trips (there is a charge for these).

See the GA Website for the full schedule and further details:
https://geologistsassociation.org.uk/festival/

Manchester Geological Association

Saturday 23 November at 1.30: The Broadhurst Lectures: The Anthropocene. Speakers: Dr Colin Waters, Leicester University, Dr Colin Summerhayes, University of Cambridge, Prof Mark Williams, Leicester University.

Saturday 7 December at 1.30: Geotourism. Speakers: Javier Carmona Carrillo, Prof Cynthia Burek, University of Chester, Dave Cropp, Martley GeoVillage.

Contact email: outdoors@mangeolassoc.org.uk For further information about meetings: http://www.mangeolassoc.org.uk/ Visitors are always welcome.

Woolhope Naturalists' Field Club - Geology Section

Friday 22 November: A Tale of Five Magmas: A Review of Planetary volcanism. Speaker Paul Olver.

Meetings are held in the Woolhope Room, in the central library, Hereford. 6.30 for 7.00 until 9.00. Non-members of the Club pay £2. Visit: http://www.woolhopeclub.org.uk/Programme.html or contact Sue Olver on 01432 761693, email: susanolver@hotmail.com

Warwickshire Geological Conservation Group

Wednesday 20 November: The Real value of Microfossils. Speaker Haydon Bailey.

Venue for talks: St Francis Church Hall. There is a charge of £2.00 for non-members. For more details visit: http://www.wgcg.co.uk/ or email: WarwickshireGCG@gmail.com. Meetings start at 7.30 with tea/ coffee and biscuits available beforehand from 7.00.

Geological Society, West Midlands Regional Group

Saturday 19 October at 10.30: Earth Science Week. Visit to Oxford University Geological Museum. Pre-register with andrewcfharrison@yahoo.com. Led by Andrew Harrison. Venue: Oxford University Museum of Natural History, Parks Rd, Oxford, OX1 3PW.

Sunday 20 October at 11.00: Earth Science Week. Building Stones of Solihull - a guided walk. Led by Ray Pratt. Meet outside St Alphage Church, Church Hill Rd, Solihull, B91 3RQ.

Tuesday 3 December 6.00 for 6.30: West Midland Regional Group AGM 2019, followed by Carbon Capture and Storage. Speaker Sam Krevor, Subsurface CO_2 research group at Imperial College London. Venue: St Martin in the Bull Ring church, Edgbaston St, Birmingham, B5 5BB.

For further details please contact the Group Secretary at: geolsoc_wmrg@live.co.uk
Click here for website.

North Staffordshire Group of the Geologists' Association

Thursday 10 October at 7.30: Human interactions in dynamic landscapes; examples from Gansu Province, China. Speaker: Dr Tom Dijkstra (Loughborough University).

Thursday 14 November at 7.30: 19th Wolverson Cope Lecture: 3D Digital Modelling. Speaker: Prof Kate Royse (BGS).

Thursday 5 December at 7.00: Christmas Social, Supervolcanoes. Speaker: Katy Chamberlain (Derby University).

For enquiries: Steve Alcock, Longfields, Park Lane, Cheddleton, Leek, Staffs, ST13 7JS. Tel: 01538 360431 or 07711 501028. Email: steves261@aol.com More info: www.esci.keele.ac.uk/nsgga/

East Midlands Geological Society

Saturday 9 November at 6.00: Sea Floor Minerals Exploration. Speaker: Paul Lusty.

Non-members are welcome and should register with the secretary. Further info: www.emgs.org.uk or email: secretary@emgs.org.uk

Teme Valley Geological Society

Monday 14 October: The deep geology of the Malverns region interpreted from reflection seismic data. Speaker: Dr Malcolm Butler, Chair of UK Online Geophysical Library.

Monday 18 November: Powering the Earth's Magnetic Field over Geological Time, TBC. Speaker: Dr Chris Davies.

Talks are held at 7.30 in the Martley Memorial Hall, on the B4197 by the Sports Ground, Martley. For field trip details and further information contact John Nicklin on 01886 888318 or visit: http://www.geo-village.eu/ Non-members £3.

Field Meeting Report

Friday 13 to Monday 16 September 2019: BCGS Field Excursion to Dorset - Part 1. Led by Alan Holliday, Richard Edmonds, John Scott (Dorset Geologists Association Group, DGAG) and Steve Etches (Etches Collection Museum of Jurassic Marine Life, Kimmeridge).

Friday 13 September: Introduction and Jurassic Coast overview

Following their visit to Shropshire and the Black Country early last summer (2018), the Dorset Geologists' Association Group (DGAG) invited BCGS on a reciprocal visit to the 'Jurassic Coast'. As we came to discover, this coastline is a long way from the Midlands and geologically very varied.

The Jurassic Coast stretches 95 miles (155km) from Exmouth (Devon) in the west, through Dorset to Swanage and Old Harry Rocks in the east. On 13 December 2001, the coastline was declared a UNESCO World Heritage Site due to its varied geology, coastal geomorphology and fossils. Our visit centred on Chesil Beach, Portland, Lulworth Cove, Durdle Door and Kimmeridge, approximately midway along the coastline.

Chesil Beach from Portland

Joining BCGS members on this excursion were several representatives from the Geological Society West Midlands Regional Group, Open University Geological Society, Warwickshire Geological Conservation Group and Shropshire Geological Society. ►

We met on Friday evening at 6.30 in the Brewers Fayre pub adjacent to the Weymouth Seafront Premier Inn, for an introductory meeting. Before dinner, Alan Holiday gave a brief overview of the Jurassic Coast, its geology and some notable features.

The Jurassic Coast represents the most complete Mesozoic rock sequence in the world, including sandstone and conglomerate, mudstones, shales and limestone. From the Carboniferous Variscan to the Tertiary Alpine Orogeny, this sequence has been heavily contorted and broken into numerous folds, basins, faults and fractures, tectonic forces having given the sequence a regional dip towards the east. During our visit, the main rock sequences we encountered included Upper Jurassic Corallian Group, Kimmeridge Clay and Portland Group, to Cretaceous Purbeck and Wealden Groups, Greensand, Gault Clay and Chalk Group. Locally these strata have been folded into the Weymouth and Purbeck anticlines.

Viewpoint overlooking Portland Harbour and Chesil Beach

Saturday 14 September: Isle of Portland

We met Richard Edmonds at 9.30 on a very sunny and warm Saturday morning in a car park near the Heights Hotel on the Isle of Portland. From a viewpoint overlooking Portland Harbour and Chesil Beach, Richard reviewed the coastline, local geology and our day ahead.

The Jurassic Coast's stratigraphy represents repetitive cyclic shallowing sequences from deep-water clays and mudstones to shallow coastal sandstones and finally calm shallow tropical / sub-tropical oolitic limestones, and then the sequence starts again. Coastal erosion has shaped the mudstone / clay strata into numerous bays and the limestone strata into headlands.

Richard explained how during Jurassic times the area sat within the Wessex Basin, stretching from Dartmoor to Southampton. The Earth's crust pulling apart with the opening North Atlantic caused the basin to experience episodic subsidence that allowed sediments to wash in and build up. Eventually this led to a Jurassic rock sequence over 5,500m thick. With sediment deposition rates exceeding subsidence rates the basin filled with sediment creating shallower sea-levels. The next subsidence episode reintroduced deeper sea-levels before sediments washed in and built up again.

From the viewpoint Richard led a short walk past the hotel, to the Isle's western cliffs, then we entered the Tout and King Barrow Quarry Nature Reserves before returning to the cars. Along the way we learnt about the local stratigraphy, fossils, geomorphology and industrial heritage.

The Isle of Portland forms a tear-drop shaped island with shingle beaches, including Chesil Beach, connecting it to the mainland. Portland and Purbeck Group rocks make up the Island and overlie the Kimmeridge Clay. A limestone layer containing black chert, the Cherty Series, sits on the Kimmeridge Clay and forms the base to the Portland Group. Overlying the Cherty Series is the Portland limestone, which includes three very different oolitic limestone beds formed in tropical / sub-tropical shallow seas close to land. The lowest (Base Bed) comprises very fine oolitic limestone with little or no shell debris. The middle layer (Whit Bed) is slightly shellier. The uppermost (Roach Stone) bed is filled with fossil gastropod (Aptyxiella) and bivalve (Myophorella) casts and molds, known as 'screws' and 'osses eads,' where the original fossils have dissolved away. These beds also contain giant ammonites (Titanites). ►

Fossil Forest in the Purbeck Beds

The Purbeck Beds, named after the Isle of Purbeck, overlie the Portland Stone and comprise thinly layered limestone, clays and shales deposited on shallow coastal flats or lagoons occasionally flooded by the sea. Environmental conditions are believed to have been similar to modern sabkhas, as seen in Northern Africa. Evaporitic deposits, small molluscs and fossil forests typify these beds. Periodic flooding producing algal (stromatolite) growth around and over tree burns or fallen trees, which included Cyprid and Monkey Puzzle types *(see front cover photo - fossil tree outside The Heights Hotel, Portland).* In places dinosaur footprints have also been preserved. Today doughnut shaped limestone masses hint at where trees once stood or lay, forming fossil forest beds known as 'caps'. The thin layers were known by quarrymen as 'slack' (or Bacon Slack). The Portland and Purbeck facies are believed to have existed simultaneously and the contact between the two is taken as the Jurassic-Cretaceous Boundary.

Looking along Portland's western cliffs, Richard showed us examples of how landslides affect the island coastline. Lower sea levels during the Ice Ages have caused ancient landslides to develop along the whole Jurassic coast shoreline. Richard showed us one such ancient landslip that had been reactivated, cracks through the old main road and in the ground hinting at the renewed movements. Waste overburden from nearby quarries having tipped over the cliff edge, added weight to the slip mass causing it to reactivate.

Landslides along Portland's western cliffs

Tectonic activity has left roughly northeast-southwest and northwest-southeast conjugate joints cutting through the Portland Group, and this reflects the island's characteristic shape. The joints feed water downwards lubricating the boundary between the Kimmeridge Clay and the overlying Portland limestone.

According to Richard, the regional stratigraphic dip has resulted in differing landslide mechanisms acting on Portland's eastern coast compared to the west. On the west coast we saw toppling Portland Limestone blocks, the heavier overlying limestone pushing down on the underlying relatively softer Kimmeridge Clay and the regional stratigraphic dip forcing the blocks to topple away from the cliff face. On Portland's east coast, the seaward stratigraphic dip results in translation landslips where overlying blocks slide along bedding planes. A good example is the Great Southwell Landslide, the largest historically recorded landslide in the UK, on the south-east coast. ►

Walking through Tout and King Barrow quarries we saw the Portland and Purbeck Beds exposing the legacy left behind from the quarrying practices. Narrow gullies, tunnels and cut faces revealed where stone had been removed. Chisel marks, drill holes and other surface features were still apparent. Trackways for former mineral railways crossed the quarries. Beaches, or stone walls, were constructed using waste rock to hold cranes which lifted out Portland Stone blocks ready for transporting away from the quarry.

Tout quarry with former trackway

Very strong Portland Limestone makes an ideal building stone and was what the quarrymen laboriously sought. Extracted since Roman times, the stone was originally quarried by hand utilising the conjugate joints to extract it. The 1970s saw quarrying switch to more mechanical means. The stone was used in many London buildings after the Great Fire of 1665, was an important building stone after the war and was used in many war grave monuments. It has also been used for sea defences along the Jurassic Coast. Closer to home all three Portland Limestone beds can be seen in the Birmingham City Centre building stone trails, as devised by Ruth Siddall for BCGS.

Returning to our cars we headed to the Bridging Camp on the East Fleet lagoon northern shore for a picnic lunch. Across the lagoon, Chesil Beach rose like a barrier against the English Channel beyond.

Chesil Beach and East Fleet Lagoon

From our earlier view point on the Isle of Portland, and now standing on the East Fleet northern shore, Richard talked about Chesil Beach, its geology, geomorphology and formation. We spent the afternoon walking eastwards along the northern shore towards Ferry Bridge examining Upper Jurassic rocks that included the Corallian Group (Osmington Oolite and Preston Grit) and the Kimmeridge Clay.

Stretching from west to east from Abbotsbury to Ferry Bridge, Chesil Beach forms a barrier beach protecting the mainland from winter storms such as those experienced during 2012 to 2013. The beach comprises a silt and clay core with a chert and flint shingle cover that reaches 15m in height. As the shingle becomes saturated during storms, waves break over the beach.

Before Portland Harbour was developed into the existing harbour, naval station, marina and sailing academy it was a big mere and marsh that allowed water to drain seawards through the beach. However, development upset this balance and after big storms in the 1980s a large drainage ditch was constructed, and filled with gabion baskets to aid drainage under the beach. Gabion baskets placed on the beach crown also help to prevent it from being eroded during winter storms.

Chesil Beach, along with the landslides, carved bays and headlands represent three main geomorphological elements seen along this coastline. The chert and flint shingle coating the beach was derived from landslides in east Devon and west Dorset. Lower sea-levels during the last Ice Age caused pre-existing landslips along the Devon / Dorset coastline to relax forming vast gravelly silt and clay fans. After the Ice Age the warming climate and rising sea-levels eroded the fans washing away the finer sediment. Longshore drift carried the remaining gravel eastwards to be deposited as Chesil Beach. ►

Fleet Lagoon and Chesil Beach showing Cans

Viewing the beach from the northern Fleet coast, we could see its true scale. Large conical scours locally known as 'cans' scarred the beach's northern edge. The scours appearing to grow in size relative to the beach height. These features result from high seas, during storms, flowing through the shingle over the clay-rich core and out through the northern side pushing the shingle with them.

Chesil Beach's clay-rich core represents fine material washed up from the seafloor as sea levels rose after the Ice Age. Similar beaches to Chesil Beach probably formed during each previous interglacial period. The sloping ground where we sat for lunch represented the ancient land surface, protected from erosion due to the presence of Chesil Beach. Should the beach disappear, the relatively soft rocks behind will erode, potentially pushing the local coastline towards Dorchester approximately 12km to the north.

Large peaty lumps washed up on Chesil Beach from the seaward side provide evidence that the beach is migrating inshore. Peat deposits running out seawards beneath Chesil Beach formed under earlier Fleet Lagoon incarnations. The Beach's northern migration exposes the peat on its seaward side leaving it vulnerable to being ripped up and washed onto the beach during stormy conditions.

Chesil Beach and the Fleet Lagoon cut across the Weymouth Anticline, therefore exposing various Jurassic strata. The first stratum we encountered was Corallian Group, Osmington Oolite deposited during the lower part of the Upper Jurassic. This stratum is best exposed at Osmington Mills, east of Weymouth, and comprises creamy yellow fossiliferous oolitic limestone. Fossils include molluscs (gastropods, ammonites, bivalves), brachiopods, echinoids, worm and arthropod burrows (including Thalassinoides) and rare dinosaur bones. The nature of this stratum and its fossil fauna indicate deposition under warm tropical / sub-tropical shallow marine conditions close to shore.

Walking further east from our starting point at the Bridging Camp, we encountered the Preston Grit, an orange-red-brown fossiliferous sandstone rich in ironstone concretions. Similar in age to the overlying Osmington Oolite, this stratum is rich in oysters and bivalves. Other fossils include ammonites, belemnites, worm burrows and serpulid worm tubes. As the heavier Preston Grit pushes downwards, the underlying clays are squeezed up like toothpaste through cracks and fissures forming softer grey patches. This stratum formed under shallowing marine conditions.

Burrows in the Osmington Oolite

The underlying clays are the base of the overlying Upper Jurassic Kimmeridge Clay, which is best exposed in Kimmeridge Bay further east along the coastline. This stratum represents returning deep marine conditions following another subsidence episode within the Wessex Basin. The overlying Portland and Purbeck Groups formed as the basin subsequently filled again, creating shallow marine conditions. ►

Retracing our steps to the cars, we said farewell to Richard before heading back into Weymouth and dinner. I would like to thank Alan and Richard (Friday and Saturday), and John and Steve (Sunday and Monday) for their time and making a very interesting visit. ■

The second part of our visit, covering 15 and 16 September will be included in the next newsletter.

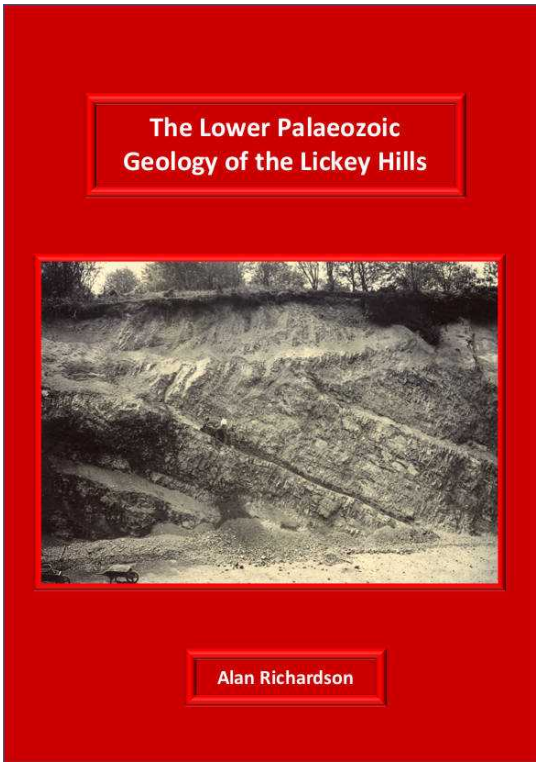
For more information about the Jurassic Coast see:

- Geologists Association Guide No. 22: 'The Geology of the Dorset Coast', J. C. W. Cope. 2nd Edition.
- Geology of the Wessex Coast by I. M. West: www.southampton.ac.uk/~imw/
- BGS Map Sheet 342 / 343: Swanage, 1:50,000 Series, Solid and Drift, dated 2000.

Andy Harrison

'The Lower Palaeozoic of the Lickey Hills'

by Alan Richardson



The Lickey Hills Geo-Champions emerged from the Herefordshire and Worcestershire EHT's 'Champions' project as a dynamic group of volunteers, inspiring a deluge of new research to increase our understanding of the complex geological structure of the Lickeys. Interest was boosted by the recent EHT's 'Voyages in Deep Time' project. This resulted in a new information panel devised by the Champions in liaison with the EHT and the Lickey Hills CP Ranger team. This was described in an earlier issue of our newsletter (No. 249, June 2018).

Group member Alan Richardson has been in the forefront of this drive to learn more about the geology of the Lickey Hills. Alan is also a BCGS member, and former Head of Geology at Halesowen College. His involvement with the Champions group has led him to some innovative new interpretation which is described in this welcome up-date to earlier published papers and booklets.

'The Lower Palaeozoic of the Lickey Hills' summarises the research and new discoveries by the Lickey Hills Geo-Champions and others since the original EHT Champions 'Barnt Green Road Quarry' booklet was published in 2011. Alan has included some published material by earlier geologists and brought our knowledge of Lickey Hills geology up to date. This is a beautifully produced booklet with numerous photos and illustrations, and Alan has generously decided that it should be freely available. It is now on the Champions website to view or download here:
https://ehtchampions.org.uk/ch/wp-content/uploads/pdfs/Lickey_Geology_Review_2019_v3.pdf

We hope this publication will inform and inspire others to become involved with the gradually unravelling geological story of the Lickey Hills. ■

Julie Schroder

Ballachulish Slate

Slate is one of those commonplace commodities that turns up all over the place in both time (the geological column) and place (the world over, especially on roofs!). Who hasn't been aware of vast waste tips littering many corners of, in particular, 'Ancient' or 'Palaeozoic' Britain. If one includes the 'pseudo-slates' (i.e. not true metamorphic varieties) such debris even litters parts of the sedimentary tracts of 'Mesozoic Britain'. I can't offhand think of any younger, Cenozoic, examples, but someone will no doubt put me right on that!

Ballachulish East Quarry, with the distinctive 'Pap of Glencoe' in the left background.

Slate has also been a substance of great importance in human affairs, quarrying the stuff having been a substantial activity since at least Roman times onwards, in particular providing a livelihood for many a family during the 18th and 19th centuries. Most familiar to us in Britain in the past would probably be Welsh slate, but far bigger operations are still active today in places like Spain, Brazil and China.

Against this broad perspective, then, it is clear that the story of just one particular set of quarries, the subject of this brief note, is little more than a minor footnote in the overall history of the subject. Nevertheless, if you are ever passing through the village of Ballachulish on your way to other parts of the Highlands or Islands, you may find it of interest to pause for an hour or two to follow the well laid-out trail around the 300-year old workings in the quarries at the eastern end of the village (at East Laroch to be more specific). There are other less presentable quarries at West Laroch, North and South Ballachulish. The nearby visitor centre provides a suitable place to park a car (at no charge).

Ballachulish Slate forms part of the Lower Dalradian succession, dated around 650, perhaps 700 million years old, and so considerably older than Welsh, Lakeland or Cornish slates. They are relatively high in iron and sulphur which impart a bluish-grey colour or combine to form small cubes of iron pyrites which weather to form rust spots and have the unhappy effect of ruining the cleavage on which the use of slate depends. The wastage rate could be as high as 75% at times, but another source records that 'Ballachulish slates got 5/- *(shillings, or 25p for younger readers!)* more per thousand than any other Scottish, Welsh or English slate because of their superior quality. They were less liable to break so this extra could afford to be given for them'. ►

Part of the main quarry

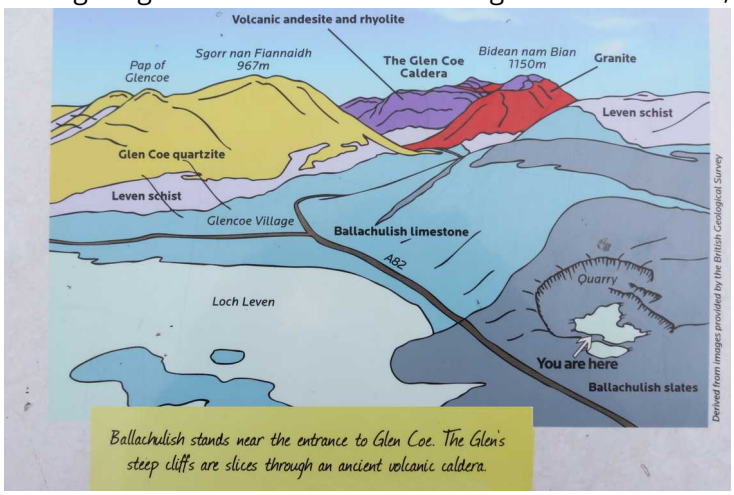
Ballachulish Quarry, showing bedding (shallow), cleavage (steep), basalt dykes (2 - pale brownish) and a quartz vein

Slate quarrying in Ballachulish goes back to the year 1693, when the West quarry was opened. This date is of some resonance in the area, coming only a year after the Glencoe massacre just up the valley to the east. A new and more positive chapter in history was therefore needed, and 1694 saw the opening of the East quarry. The direct workforce, drawn from both near and afar (especially from Cumberland), was often around 300. According to the standards of the time, work was reasonably well remunerated and many labourers housed in decently maintained properties on the Ballachulish Estate. Together with supporting activities, many of the local villagers would have benefitted from this industry, although one imagines that not everything was for the better: more noise, more dust and occasional tragic accidents.

Jobs were secure and output was steady throughout most of the life of the quarries, which only closed finally in 1955. Some sources state that 26 million slates were produced in 1875, perhaps marking the high point of production in later years. By this time improvements in quarrying had come from better machinery and Alfred Nobel's great innovation (the use of safer dynamite patented in 1867). This was before the boost given by a branch line from Oban in the rail network, in 1903, had been delivered. 5 to 10 million slates per annum would seem be a more typical output.

One of the surviving slate dressers' boat sheds

The lives of many labourers in quarrying and similar extractive industries has also been improved through legislative controls on working conditions. Thus, the Truck Act of 1887 set limits to the old system of 'payment in kind' whereby many employers could create a position of 'debt bondage' for their employees, whose wages (paid in arrears) would often be offset by the provision of goods and services 'on the slate' from company stores while workers awaited payday. Alternatively, wages were paid in the form of company tokens, exchangeable only in the company stores, often at inflated rates: this having the same effect of keeping workers beholden to their unscrupulous employers. ►



The local Ballachulish / Glencoe geology explained

As the quarry grew bigger and higher, an arched incline was constructed of slate in 1822 to facilitate delivery of the quarried material to the lochside for shipment. Part of this beautifully built structure, now a designated scheduled monument, can still be admired, and is one of the highlights of the quarry trail. Other unique survivals are several slate boathouses down at the marina where at one time the slate-dressers used to split and shape the slates before onward distribution, though these buildings are in poorer condition than the incline.

The magnificent slate arch, partially restored

The main part of the trail, naturally enough, runs through the East quarry itself, where several information boards explain the history of the site. One of the more arresting panels illustrates the local geology, and in particular Glencoe with its celebrated collapsed caldera and distinctive quartzite hillock ('The Pap'), all part of the Lochaber Geopark. Many geological features can readily be seen on the quarry faces, including the steeply inclined slaty cleavage itself, intrusive dykes, prominent quartz veins and traces of original bedding. Two small lochans seem to attract some interesting feathered visitors, which might add spice for the bird-watcher. Other information boards tell the story of two long-running industrial disputes in the early 1900s over the provision of medical care and the tale of the 'dispute-stone', a large quartz boulder preserved on-site by devious means!

All in all, the Ballachulish Slate trail offers a varied, well rounded experience, with something for all tastes, and perhaps leaves us thankful that we live in more enlightened times! ■

Mike Allen

Mike's Musings No. 23, The Eyes Have It - Part 1

Creatures have many different ways of sensing the world around them. For human beings *taste, touch, smell* and *hearing* (and also the less familiar senses of *proprioception* and the *vestibular system* – giving us our sense of position, orientation and balance) are all very useful in their own way, but the sense that arguably rises above all these in enabling us to navigate our environment is that of *sight*. This power of vision, in its broadest sense, has evolved many times (estimates vary from 40 upwards) within the animal kingdom. Much of the following investigation into the different ways of 'seeing' comes from Richard Dawkins' admirable book 'Climbing Mount Improbable', more specifically the chapter on the 'Forty-fold Path to Enlightenment', which sounds more like something out of Confucius! ►

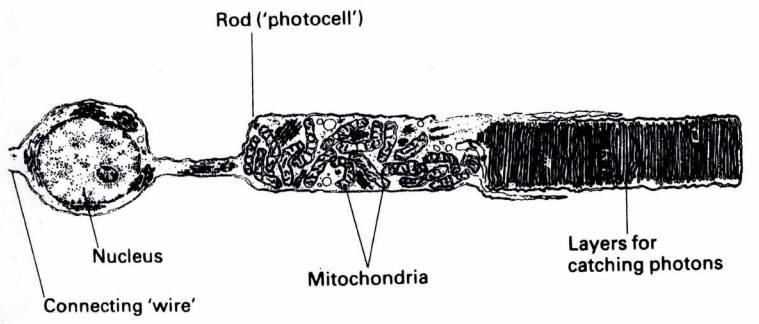


Figure 5.2 Photon-capturing device or 'biological photocell': a single retinal cell (rod) and (cones) of a human.

Dawkins is, of course, well known for his rants at the expense of Creationists, who like to quote Darwin's apparent self-confessed doubts as to whether his notion of 'Natural Selection' can adequately explain something as intricate as the eye. The full quotation, Dawkins points out, is rhetorical, and anything but shy of self-confidence. Indeed, the full landscape of variation in eyes across the animal kingdom serves only to illustrate rather well how 'Natural Selection' operates to produce all of nature's wonders.

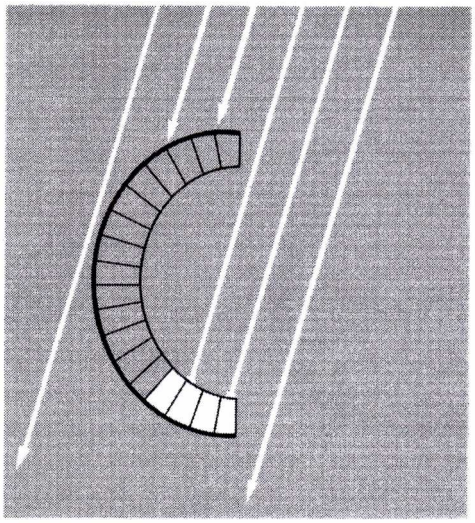


Figure 5.3 A simple cup eye can detect the direction of light.

The simplest kind of eye might not really warrant the term 'eye' at all, and is nothing more than a *sensitivity to light radiation* within the general body wall of the organism itself. Such a **simple eye** or **pigment pit** (an *ocellus*, pl. *ocelli*, sometimes referred to as an 'eyespot', unwisely so, as this can have other connotations), cannot detect the direction of incoming light, and is certainly unable to form any kind of image. Remarkably, this condition exists in some single-celled organisms, where the photoreceptor is just one component of the cell (a modified chloroplast). Some jellyfish and some kinds of worm also have little more than this with which to 'see' the world around them. Most extraordinary of all seems to be the presence of light-responsive cells in butterfly genitalia, male and female, which serve as an aid to sexual activity.

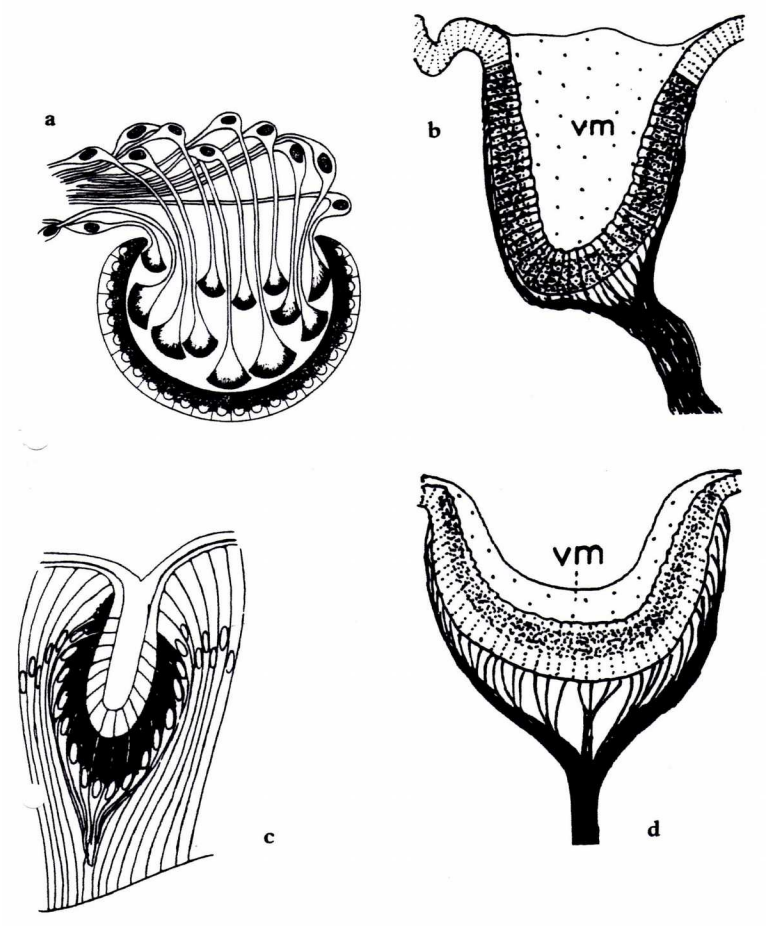


Figure 5.4 Cup eyes from around the animal kingdom: (a) flatworm; (b) bivalve mollusc; (c) polychaet worm; (d) limpet.

This fundamental step on to the 'ladder of vision' begs the question of what we mean by sight. Light rays consist of a stream of particles called *photons*. When a photon strikes an atom or molecule, that atom or molecule is altered and some energy is released. This energy in turn stimulates a nerve cell. Different kinds of stimuli acting on different coloured *pigment molecules* add up to what we call the process of seeing. We imagine that photons are plentiful (especially during daylight hours), but for many environments, such as deep in the oceans or underground, the reality is otherwise. This was especially so when animals were first making their mark on the world. Further improvements come with increasing the number of *light-receptive cells (photocells / photoreceptors)* and the way in which they are arranged, in order to increase the ability to capture more photons. ►

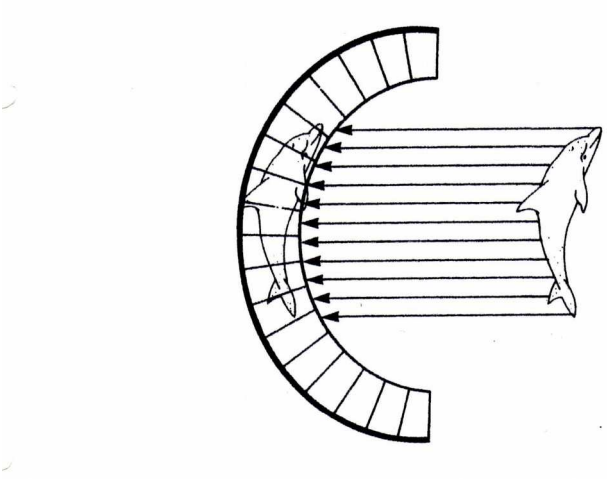


Figure 5.5 How eyes do not work – would that light rays were so obliging!

The first, and most obvious, way to improve matters is to increase the number of layers of photocells, and to arrange them in a regular pattern, wired up efficiently to a nerve ending via mitochondria and cell nucleus. This arrangement constitutes the basis of all *retinal cells* (Fig. 5.2). These photocells must then be grouped into an effective array for discriminating subtle variations in the intensity of incident light. This translates into a patterned image; light or dark, or somewhere in between. A *blob-like transparent photocell* gathers light from all directions but cannot effectively compute the direction of the light source. Such an 'eye' has to change its own position in order to determine the light source, and some maggots adopt this simple tactic to steer towards or away from light.

The next trick is to be able to differentiate between light coming from different directions such that moving objects might be detected, rather than merely sunlight arriving from the infinity of space. The simplest way to achieve this is to coat one side of the photocell with an opaque layer. If such *direction-sensitive photocells* are then arranged to each point in different directions they can build up a 3-D sense of where light is coming from. The most sensible arrangements would seem to come from arranging the photocells in a regular curve, which might be either ***concave*** or ***convex***.

If we follow the ***concave path*** to begin with, we end up with a *cup-like* array of photocells (the *retina*) (5.3) producing the so-called **camera eye**. Light coming from one direction will only stimulate some of the photocells, enabling a perception of that direction. A deeper cup enhances this effect, leading to a more-or-less spherical eye shape. Many 'lowly' creatures have such eyes, including various worms and molluscs, (5.4) and, of course, they are not limited to just two. However, the way in which light rays travel around such a *simple 'open-cup'* means that an infinite number of images results in total confusion: effectively no image at all (cf. 5.5 / 5.6). We need a way to restrict the multiplicity of light rays reaching the retina. The simple answer is the **pinhole eye** (5.7). This is achieved by the expedience of deepening the cup to leave just one tiny point of entry (the *aperture*) for light rays to enter. The celebrated survivor of the ammonite clan, *Nautilus*, has just such an eye (5.8 a). ►

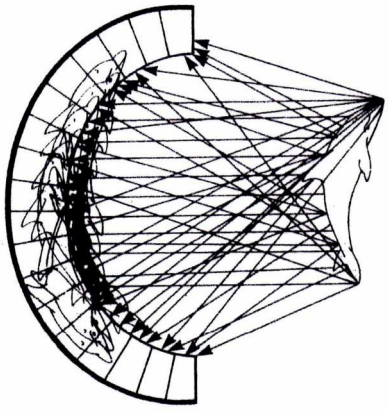


Figure 5.6 Light rays from everywhere go everywhere and no image is seen. An infinite number of dolphin images clash with each other, and nothing is clear.

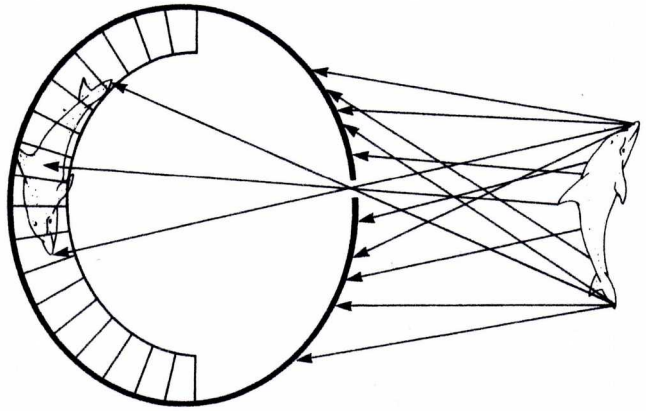
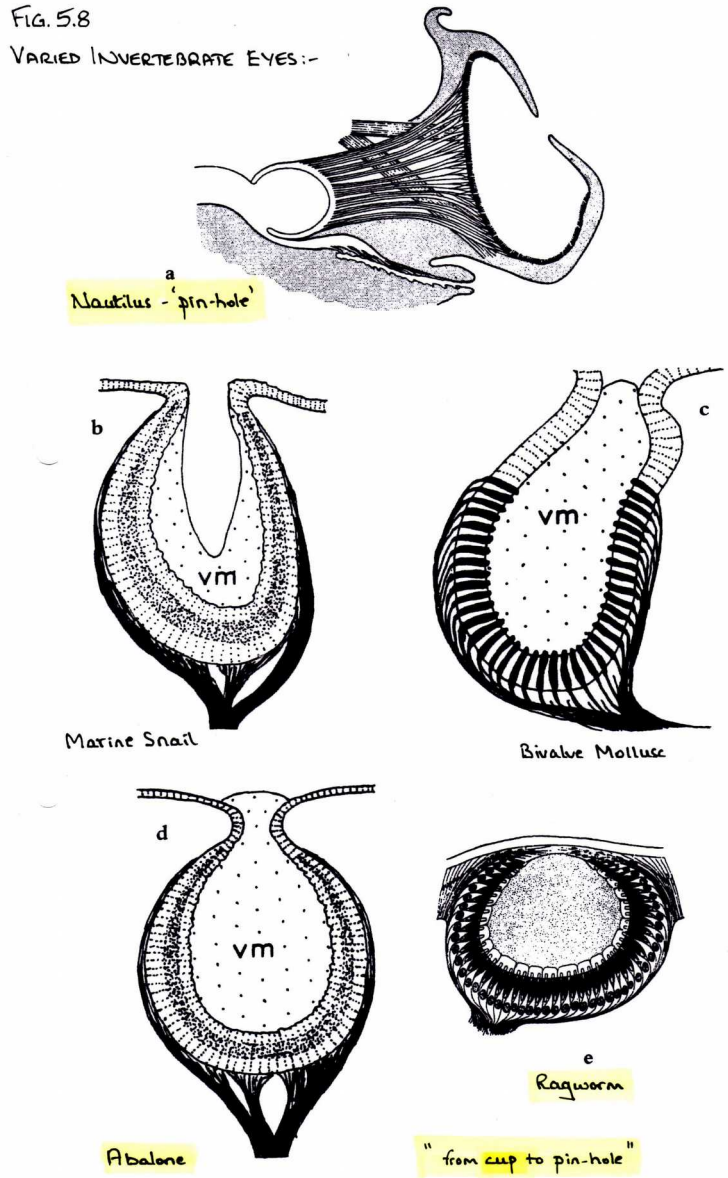


Figure 5.7 Principle of the pinhole eye. Most of the competing dolphin images are cut out. Ideally only one (inverted) gets through the pinhole.



The unfortunate side-effects of this are a stand-off between the sharpness and brightness of an image (bright and fuzzy or dark and sharpish) that is moreover formed both upside down and left-right reversed (see 5.7). These drawbacks can be overcome by the simple expedience of a *lens*. I say simple, but the detail can get very complicated when we consider such devices as optical microscopes and telescopes. The basic function of a lens is to both brighten and sharpen the image by gathering light rays across a larger diameter than a pinhole, and by refracting such rays in such a way as to bring them into focus at a single point on the retina. Nature however, and as ever, seems to find a way to cope with such complexity and has come up with many designs ranging from the imperfect '*blob-of-vitreous matter*' to *complex lenses with graded refractive power*. Ragworms and abalones are just two simple creatures which incorporate a lens-like mass of transparent vitreous matter in their '*cup-eyes*' (5.8 d/e). Originally, this may have merely served as a protective layer upon the retina, but had the happy side-effect of improving the formation of an image. ■

In the next part we shall examine further sophistication in the design of the ***camera-eye.***

Mike Allen

Reference: Figures from Chapter 5
'Climbing Mount Improbable'
by Richard Dawkins
Penguin: Popular Science
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