Newsletter No. 294
December 2025

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To find out more - read on!

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Copy date for the next Newsletter is Sunday 1 February

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For enquiries about field and geoconservation meetings please contact the Field Secretary.
Please notify Andy Harrison in advance if you will be attending these events.
To submit items for the Newsletter please contact the Newsletter Editor.
For all other business and enquiries please contact the Honorary Secretary.
For more information see our website: bcgs.info, YouTube, and Facebook.

Future Programme

Indoor meetings are now held in the Lamp Tavern, 116 High St, Dudley, DY1 1QT
7.30 for 8.00 o'clock start unless stated otherwise.
Visitors are welcome to attend BCGS events but there will be a charge of £1.00.

Monday 15 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. Enjoy a few short talks from our members. Bring along any interesting geological specimens you would like to show us, or which you would like to be identified - there may be someone in our midst who can help!

Monday 19 January *(Indoor Meeting):* 'Bringing Forward the Past: Black Country Geology, Past, Present and Future'. Speaker: Graham Worton (BCGS Chair and Keeper of Geology for Dudley).

Saturday 14 February 2026 *(Geoconservation Day):* Smestow Valley (plus Erratics at Wightwick Manor and the Mount - details TBC). Leaders for Smestow Valley: Smestow Valley Country Park Wardens and Friends of Smestow Valley. Meet at Smestow Valley Local Nature Reserve, Meadow View Terrace, Wolverhampton WV6 8NX (Grid ref: SO 891 999), 09.45 for a **10.00 start**. The morning will involve a geology and biodiversity walk and get to know the Friends of Smestow Local Nature Reserve whilst discussing future opportunities at the site. Wear suitable outdoor clothing for the weather conditions. We will aim to finish this session around 12.30. Either bring a packed lunch or you can purchase lunch locally. Resume the field trip at Wightwick Manor at 1.45. Details TBC.

Monday 16 February *(Indoor Meeting):* '*Spicomellus*: the punk rock dinosaur of the Jurassic'. Speaker: Richard Butler (Professor of Palaeobiology at the University of Birmingham). (More details on our website: bcgs.info).

Saturday 14 March *(Geoconservation Day):* Portway Hill, Rowley. In collaboration with the Friends of Portway Hill Group and the B&BC Wildlife Trust. Meet at St Brades Close just off Tower Road at 09.45 for 10.00 (Grid ref: SO 974 893), nearest PC: B69 1NH. Directions: from Birmingham New Road (A4123) turn left on to Tower Road if coming from Birmingham, right if coming from Wolverhampton. Just after Bury Hill park, turn left onto St Brades Close. Wear old work clothes, waterproofs and stout footwear. Please bring gloves. Tools provided but do feel free to bring your own. Also bring a packed lunch, hot drinks provided. Aim to finish around 2.30.

Monday 16 March *(Indoor Meeting, 7.00 for 7.30 start):* AGM followed by 'Conserving Geoheritage: in (and out) of Staffordshire'. Speaker: Dr Jonathan Larwood (Principal Officer - Geodiversity Natural England).

Saturday 11 April *(Field Event):* Visit to the Ercall Quarries, Shropshire. Leader David C Smith (SGS). Details TBC.

Monday 20 April *(Indoor Meeting):* Details TBC.

Other Societies and Events

Shropshire Geological Society

Wednesday 14 January 2026: 'Geology of the Core-Mantle Boundary'. Speaker: Prof Sebastian Rost (University of Leeds).

Wednesday 11 February, Darwin Week Public Lecture: 'Darwin and Wallace'. Speaker: John Fraser King.

Meetings commence at 7.00 for 7.15. Lectures are now being held in hybrid form, in person at the Higher Education Centre, Shrewsbury College, as well as by Zoom. If you wish to attend please contact Albert Benghiat: 07710 421 581, email: SGS.chair@hotmail.com
Further information: https://shropshiregeology.org.uk/

Warwickshire Geological Conservation Group

Thursday 15 January, 2026: 'The Charnwood Terrane Revisited'. Speaker: Tim Pharaoh. Register in advance to attend virtually:
https://us02web.zoom.us/meeting/register/WNDsw2L8Q1CYSg_AUxmBxQ

The meeting is at 7.30 in St Francis of Assisi RC Church, 110 Warwick Rd, Kenilworth, CV8 1HL.
For more information and booking visit: https://www.wgcg.co.uk/

East Midlands Geological Society

Saturday 13 December: 'Reconstructing late Quaternary hydroclimates; lessons from local to global scales'. Speaker: Professor Matthew Jones.

Saturday,10 January 2026: 'Late Ordovician subduction, super-eruptions and closure of the Tornquist Sea'. Speaker: Dr Tim Pharaoh.

Lectures are from 6.00 to 7.00, and are normally held in the School of Geography Sir Clive Granger Building on the Nottingham University Park campus. Non-members are welcome at all of our lectures and attendance is free of charge. Further info: www.emgs.org.uk

Woolhope Naturalists' Field Club - Geology Section

Friday 16 January 2026: 'The fate of ocean oxygenation in a warming world'. Speaker: Dr Babette Hoogaker, Heriot-Watt University.

Meetings are in Hereford Town Hall, from 6.00 to 8.00. Non-members are welcome and pay £2. More info. at: https://www.woolhopeclub.org.uk/meetings

Manchester Geological Association

Saturday 13 December: 'Microfossils'. Speaker: Mike Horne, of Hull Geological Society. This meeting is on Zoom and scheduled for 1.30.

Saturday 17 January, 2026: This meeting will start at 1.00, at the University of Manchester.

Gordon McKeown (Vice-Chair of the NSGGA): **'Hard times in Cheshire's Triassic Badlands'.** Bracketed by two of the 'big five' mass extinctions, the Triassic Period was pivotal to the evolution of life. Britain was land-locked, part of the Pangaea supercontinent and experienced severe environmental conditions. The lecture will examine the structure and stratigraphic succession of the Cheshire basin, and trace the evolution of Cheshire through the Triassic using evidence from five interesting sites.

Dr Margaret Hartley (Manchester) will talk about **'Resources for the Modern World - Rare Earth Minerals'.**

Professor Christopher Clark (Sheffield) will talk on the **'Rise and Fall of the British-Irish Ice Sheet.'**

The Venue is The Department of Earth and Environmental Sciences at The University of Manchester, located in the Williamson Building, 176 Oxford Road, Manchester - opposite The Manchester Museum. Please contact us at info@manchestergeology.org.uk to book on to these events.

Teme Valley Geological Society

Monday 26 January 2026: 'Precambrian dolomite: detectable diagenesis under the seabed'. Speaker: Prof. Ian Fairchild.

Talks take place in Martley Memorial Hall at 7.30. Non-members £3. For further information email: enquire@geo-village.org or visit: https://geo-village.org/

Editorial

As we come to the end of our 50th anniversary year, we have much to look back on and to be proud of as our Society continues to fulfil its original intentions. These are to conserve local geological sites, provide field visits to improve geological awareness and understanding 'in the field', and indoor meetings to continue this process in a comfortable and convivial setting. Our special anniversary weekend fulfilled all these aims, and resulted in a slight increase in membership.

On a practical note, it's nearly subscription time again! The renewal form is at the end, p.24.

This last Newsletter of our 50th anniversary year is bulging with much to keep you amused, interested and informed over the Christmas holiday, so I will keep this short. A big thank you to all those who helped to make our special 50th anniversary events so successful and a Merry Christmas to you all. ■

Julie Schroder

Field Meeting Report

Saturday 7 and Sunday 8 June: Field Event: Visit to the Yorkshire Museum of Natural History, Sheffield and Biddulph Grange Gardens and Geological Gallery, Staffordshire.

Saturday 7 June - Yorkshire Museum of Natural History, Sheffield. Led by Brian Andres (Museum Curator)

Introduction

In early June, seven BCGS members travelled to Sheffield to visit the Yorkshire Museum of Natural History (YMNH) at 149 Holme Lane, Sheffield, South Yorkshire S6 4JR. This followed from an invitation received in 2023, not long after the Museum had opened to the public on 13 August 2022.

Described as a 'mini-museum', the YMNH is relatively small and dedicated to making science as publicly and academically accessible as possible. Housed in two buildings, the Museum operates as both a repository for specimens and an independent research organisation. The main Museum, open to the public and researchers, is housed within a two-storey, red brick building situated next to the River Loxley. A nearby second building is used to conserve and prepare specimens, often for third-party institutions, and has CT-scanning and 3D printing facilities to see inside and create copies of specimens. It may be small now, but the Museum has a five-year business plan to grow steadily and eventually to move into bigger premises. ►

Inside, the main Museum building is divided into three (Green, Orange and Blue) Zones. The Green Zone covers much of the ground floor and contains private and public laboratories. The Orange Zone includes the ground floor entrance area and the Dino Stairwell leading up to the first-floor gift shop/reception. Occupying the first floor is the Blue Zone, which contains the Main Gallery, a research library and a conference suite. Our tour was mainly focussed in this zone.

Main Gallery, Yorkshire Museum of Natural History

The Collections

Museum collections are split between three departments dedicated to the Earth Sciences, Life Sciences and a Library & Archive.

With over 10,000 specimens, the **Earth Sciences Department** is constantly growing and is divided between the Palaeobiology and Mineralogy collections. Within the Palaeobiology collection the palaeontological specimens form the largest part of the Earth Sciences Department, and many specimens were collected during the 19th century, by the pioneering founders of palaeontology. The Palaeobiology collection is split into the **vertebrates** - including marine reptiles, dinosaurs, crocodylomorphs (crocodiles), mammals, fish and amphibians, and the **invertebrates** - including ammonites, other molluscs, bivalves and brachiopods, corals, echinoderms and sponges. The smaller Mineralogy collections include various oxide, sulphide and silicate minerals from Cornwall, Cumbria, Derbyshire, Staffordshire and the Yorkshire Coast.

Ammonites on display

The **Life Sciences Department** is split between the Botany and Zoology collections, which aim to educate the public in understanding biodiversity and the environment. All of these collections are on display for the public to see and specimens are available to researchers upon request.

The **Library & Archive** holds books and journals, geological maps, movie props (including some from Jurassic Park), artistic works and time capsules for research purposes.

Being dedicated to education, the Museum hosts school visits, a fossil club for kids, Palaeo-Internships for graduates, online resources for schools and universities and a blog page. It also offers guided in-depth museum tours, public lectures - at 2.00 every Saturday, and a laboratory experience where visitors can learn how scientists extract and prepare fossils from rock.

Our Visit

We met at the Museum gift shop/reception on a rather damp and grey Saturday around 12.00, where our guide, Brian Andres (Museum Curator), was waiting to greet us. Originally from Texas, Brian ►

spent some time lecturing at University College Birmingham (formerly Birmingham College of Food and Domestic Arts) before moving to the YMNH. After an initial introduction, Brian gave us an in-depth guided tour through the Main Gallery.

The Main Gallery is a large rectangular space with glass-fronted cabinets along one wall, and glass display cases dotted around, displaying various marine reptile and dinosaur skeletons, dinosaur wallpaper and several models. Our tour lasted around two hours and there was a discussion on mineralogy (the 'stuff' that makes up the fossils). This was nicely illustrated from many ammonite, belemnite and other mollusc examples. Brian explained how the fossilisation process occurs and how, after burial, minerals including, most commonly, calcite, but also quartz, opal and pyrite eventually replace the original organism.

Velociraptor skeleton and dinosaur wallpaper

Invertebrate fossils

This was followed with a quick tutorial on fossil hunting in Yorkshire. Whilst fossils are common countywide, the best place to look for them, particularly in Yorkshire, is along the coast such as around Scarborough, Whitby and Robin Hood's Bay. This kind of fossil hunting Brian likes as it's 'literally a walk on the beach'. Fossils typically occur within mineralised nodules known as 'cannon balls', which can be carefully cracked open using a hammer and chisel to reveal the fossil inside. However, at these locations it is important to keep an eye on tide times and not to go beneath cliff faces without protection, since it is the cliffs which contain the fossils which fall out. Therefore, wearing helmets and eye protection is important when fossil hunting at these locations.

Ichthyosaur specimen

Bringing the nodules back to the lab, palaeontologists can carefully open them under a controlled environment and either CT scan them to look inside and/or produce 3D printed models to put on display. Environmental conditions need to be carefully regulated to avoid damaging the fossils. This is particularly important for those formed from pyrite that, when exposed to air and moisture, tend to tarnish and rust - a condition called 'Pyrite Disease'.

Typically, ammonites are the most common fossil found on the coasts, closely followed by belemnites, vampire squid and coprolites. Looking at the ammonites and belemnites in particular, Brian explained what these organisms looked like, their living and feeding habits and what they tell us about ancient environmental conditions. Carving snake heads on ammonites was popular during Victorian times. Called 'snake stones', these were sold to London tourists as 'curiosities' and some could be seen on display. Other fossils found on Yorkshire's beaches include brachiopods and bivalves, corals and black very high-quality coal, which, when carved and polished is known as jet. ►

Yorkshire coastal invertebrate marine fossils are comparable with those on Dorset's Jurassic Coast. Therefore, Brian could not help but speak about the Palaeontologist's heroine, Mary Anning. He gave a brief account of her life and remarkable discoveries that included marine reptiles and coprolites.

Vertebrate fossils

Leaving behind the invertebrates, Brian moved on to the vertebrates and reiterated how the Earth Sciences Department's Palaeobiology collections dominated the Museum displays with specimens typically found in and around Yorkshire. The vertebrate fossils generally fall into three geological time periods: the **Carboniferous** (around 300 Ma), the **Early to Middle Jurassic** (180 Ma to 190Ma) and the **Late Cretaceous**. To some extent, there is also the **Ice Age.**

The Museum's Jurassic fossils form the biggest collections and represent a time when England was a series of tropical islands in a warm ocean environment close to the equator, much like the Caribbean or Hawaii today.

Therefore, most Yorkshire Jurassic fossil vertebrates are marine in origin and include ichthyosaurs and plesiosaurs. **Ichthyosaur** means 'fish reptile'. Whilst resembling modern dolphins, they had four flippers rather than two, a vertically orientated tail and the largest known eyes on record within the animal kingdom. They fed on ammonites, which they would sneak up on from behind, bite the shell and squeeze out the animal inside before eating it. One specimen named Isobel, was fossilised with a young foetus illustrating that ichthyosaurs gave birth to live young.

Plesiosaurs generally come in two varieties: long necked with short heads (Plesiosauroids) and long heads and short necks (Pliosauroids). Plesiosauroids were specialist fish eaters. Their long necks, small heads and lots of teeth enabled them to catch fish easily from within a shoal. The much bigger and bulkier Pliosauroids, such as *Kronosaurus*, would easily have scared fish off and so it is likely that these animals generally ate whatever they wanted including other plesiosaurs and ichthyosaurs. Yorkshire is unique in having a third intermediate Plesiosaur variety called a Rhomaleosaur with a medium head size and neck length. The museum currently holds the only specimen, named Hilda, which is new to science and represents a holotype, yet to be described.

Ichthyosaur and plesiosaur dynasties co-existed through at least part of the Mesozoic Era. Ichthyosaurs appeared and diversified first, during the early Jurassic, and had all but disappeared by the early Cretaceous. Plesiosaurs appeared later in the Jurassic and diversified to dominate the Cretaceous before giving way to mosasaurs in the Late Cretaceous. *Mosasaurs* were large marine lizards, closely related to Archosaurs, the group which includes crocodiles, birds and dinosaurs.

Rhomalaeosaur specimen

A single Pterosaur is known from Jurassic Yorkshire.
Called *Peracypcephillis*, it was a relative of *Dimorphodon*, known from the Dorset Jurassic coast, but a bit more robust with a more pointed bill. *Peracypcephillis* and *Dimorphodon* nicely illustrate that whilst the Dorset and Yorkshire Jurassic coastlines have similar aged rocks, there are slight differences in environment and organisms that give a different window on the world at the time. ►

The Rest of the Collection

Whilst Yorkshire's Jurassic fossils mostly represent marine creatures, a single dinosaur example has been retrieved from its rocks. Generally, land dwellers are poor swimmers, so this begs the question: how did a dinosaur find its way out to the open ocean? The specimen in question comprises a single vertebra, found near Scarborough, which belonged to a sauropod dinosaur - possibly *Cetiosaurus*. It is likely that it ended up in the open ocean via a process known as 'bloat and float'. That is, it died on land, ended up in a river and gases resulting from its decomposition caused it to blow up like a balloon. Its bloated carcass then floated down river and out to sea where it was either punctured or internal pressures caused it to explode, scattering its remains which then settled over the ocean floor.

Leaving the Jurassic coast behind, Brian discussed the fossils from Yorkshire's Carboniferous Period, around 300 Ma, when the continents were relatively close together and nearly formed one large landmass. A vast tropical forest covered the equatorial regions and included horsetails, cycads and club mosses along with *Lepidodendron*, which was particularly abundant. Growing up to 40m in height, *Lepidodendron* was related to the clubmosses and fire resistant due to a well-developed root system. Many plants meant lots of photosynthesis. Therefore oxygen levels were high and this resulted in spontaneous forest fires and allowed insects and other arthropods - including cockroaches, scorpions, dragonflies (*Meganeura*) and centipedes, to reach gigantic proportions. In coastal areas Yorkshire's Carboniferous marine organisms included trilobites and many corals.

The final part of our tour centred around the Museum's Cretaceous dinosaur specimens displayed throughout the Main Gallery. Brian pointed out that a palaeontological museum must have dinosaurs. Since dinosaurs are generally absent from Yorkshire's fossil record, the museum's specimens come from Mongolia and China. They include the hind limb of a *Struthiomimus*, meaning 'ostrich mimic' and a very early bipedal relative to *Triceratops* called *Psittacosaurus* meaning 'parrot reptile'. This fossil is named 'Frank'. The displays also include *Yutyrannus*, an early relative of T-Rex from the Early Cretaceous, examples of *Velociraptor* from the Jurassic Park movies, *Microraptor* and several more. Brian spoke about their morphology and how current scientific discoveries, such as feathers, are challenging our previous ideas on dinosaur appearance and behaviour.

Psittacosaurus skeleton

Following the tour, we were ushered into the conference suite where Brian gave a talk on his favourite extinct organisms - the Pterosaurs. In particular he spoke about the largest one known, *Quetzalcoatlus*. Discovered in Texas in 1971, *Quetzalcoatlus* was the size of a small aeroplane, with an estimated 10 - 11m wingspan. It is named after the ancient central American God of death and knowledge. Brian talked about how his passion for palaeontology was sparked by seeing an example of the *Quetzalcoatlus* wing in his local museum. He then went on to discuss the animal's discovery, its morphology, how it fitted in with other pterosaurs and its lifestyle.

The talk lasted around one hour, and our museum visit finished shortly after 3.00. There was an option to visit the Weston Park Museum afterwards. However, given the time, we decided not to do this and instead opted to meet around 6.00 for a social evening meal at a nearby restaurant. ►

Sunday 8th June - Biddulph Grange Gardens and Geological Gallery, National Trust, Staffordshire. Led by Adrienne Noble and Barbara Kleiser, Biddulph Grange Volunteers.

Introduction

After spending the night in Sheffield, we drove to Biddulph Grange giving us a chance to visit another interesting site on the way home. The visit followed a suggestion from our newsletter editor, Julie Schroder, who learnt about the site during a key bit of restoration work in 2018. Julie wrote an article about these works in BCGS Newsletter No. 251, October 2018, titled '*The Geological Gallery at Biddulph Grange Garden*'.

Biddulph Grange Italianate Garden

Biddulph Grange is a Victorian gem and geological curio situated on the edge of the North Staffordshire moors and coalfield approximately 1.5 km north of Biddulph town centre. The site includes a Grade II listed Italianate Victorian Mansion and Grade I listed gardens covering around 15 acres (6.1 hectares). Historically it included 73 acres of woodland and moorland. Today, the National Trust owns the gardens but not the house, which has been developed into private apartments. The woodland and moorland belong to Staffordshire Moorlands District Council and form the Biddulph Grange Country Park.

James Bateman and Biddulph Grange

Biddulph Grange, Chatsworth Grit Tunnel

The Biddulph Grange estate was the dream and work of James Bateman (1811-1897) and his wife Maria (1812-1895). Bateman was an accomplished, wealthy horticulturalist and landowner whose wealth had been inherited from his grandfather, also James Bateman (1748-1824), a Cheshire / Staffordshire coal mining and steel magnate with a business empire comprising foundries, forges, cloth mills, property and banking. Bateman was a typical Victorian man of the scientific world and fellow of the Royal Society, Royal Academy and Horticultural Society with a strong religious devotion. He was passionate about orchids, ferns and geology, and it could be said, he was also an educator and naturalist.

Originally a 13th century farmhouse, the house was a vicarage when the Batemans acquired it in 1840. Both keen gardeners, they saw the opportunity to start from scratch and built the existing house, complete with glass houses and compartmentalised gardens with the help of Edward Cooke (1811-1880), a professional and successful marine painter, who Bateman met at Kew in 1847. He and Cooke both shared a passion for plants, the natural world and geology. Together, they re-sculpted the landscape into miniature hills and dales, nooks and recesses to create the individual gardens with specific mini micro-climates and exposure to sunlight, shade, dryness and moisture. They brought Chatsworth Grit boulders down off the moors to create artificial tunnels and outcrops and connected ►

the gardens with avenues of trees, a replica Himalayan glen and a stumpery using upturned tree roots. Each garden was themed on a different country representing Italy, North America, China and Egypt which they filled with plants either from that country or ones that closely matched.

Being devoutly religious, the Batemans' aim in creating the gardens was to demonstrate the work of God. The subject of geology was in its infancy and like many early geologists at the time, Bateman also wanted to reconcile geological 'deep time' with popular religious belief and the story of creation in the Book of Genesis. To this end, he built a geological gallery on the north-east corner of the house which visitors would pass through before entering the gardens.

Biddulph Grange Geological Gallery, Day 1

A long, single storey structure with a pitched roof and tiled floor, the gallery's northern wall contains seven bays, each representing the biblical days of creation, but as a longer epoch of time. Bay 1 represents the barren Earth, absent of life and displaying only granitic rocks. Bays 2 to 7 contain fossils and specimen examples that appeared in the order of the six days of creation from marine invertebrates (corals, planktonic animals, molluscs and trilobites), through early vertebrates (fish) and land plants, to complex land animals and finally mammals including early humans. There is no bay to represent day 7 of creation. It is said this was destroyed later in the gallery's history, but it is considered more likely that Bateman intended the gardens themselves to represent Day 7 and the Garden of Eden. Here, his visitors could relax and witness international examples of botanical beauty that represented what God created in varied glory laid out for all to see. On the Gallery's southern wall, there are reproduced maps and sections displayed showing the North Staffordshire Coalfield. These may originally have come from Bateman's grandfather.

Biddulph Grange after Bateman

Monkey Puzzle tree

In 1868, the Batemans retired to Kensington, London, leaving the Grange to their son, John. Financial difficulties resulted in the house and gardens being auctioned in 1871 and sold to another local industrialist, Robert Heath (1816-1893), in 1872. Taxation and economic depression after the First World War forced the Heaths to sell the estate to the North Staffordshire Cripples' Aid Society in 1923 and, two years later, after being passed to Lancashire County Council it became a disabled children's orthopaedic hospital.

After the Batemans left, the house and gardens underwent major transformation that removed much of Bateman's hard work. The Geological Gallery was abandoned and used as a storeroom, workshop and morgue. Many Gallery specimens disappeared during this time but, luckily, many ended up in the geology department at Keele University. In 1988, the National Trust took over the gardens and started a major restoration project and, after the hospital closed in 1991, the gardens reopened to the general public in May 1991. The house became derelict when the Heaths left and was eventually developed into nine private apartments. ►

The National Trust didn't take ownership of the Geology Gallery until 2002 when the local community and geologists from Keele University made its importance known. Restoration works didn't commence until 2017/2018 once enough funds had been raised to enable them to commence. The restoration works involved partly reconstructing/refurbishing the Gallery building and locating most of the missing specimens and substituting lost ones with closely matching examples. The Biddulph Grange Gallery and restoration works were brought to Julie's attention in 2018 through communications with Eric Robinson (former geology lecturer at UCL and editor of 'Geology Today', who sadly passed away in May this year).

Our visit to Biddulph Grange

After about an hour's drive from Sheffield over the North Staffordshire Moors we reached Biddulph Grange for a guided tour around the gardens and Geological Gallery. Our guide around the gardens was National Trust volunteer, Adrienne Noble who we met at the entrance next to the house. Here the Italianate style gardens are in keeping with the house and look out over the other restored gardens. Adrienne's tour included the Lime Avenue, The Pinetum and Cheshire Cottage, Egypt, the Stumpery, China, the Himalayan Glen and America. Along the way, several small geological connections revealed themselves.

The Pinetum contains impressive clumps of monkey puzzle, firs, spruce, cedars, pines, sequoias and larch all planted by Bateman. More recently, the National Trust have added a Ginkgo (*Ginkgo biloba*) and Wollemi pine (Wollemia nobilis). Did Bateman know that his monkey puzzles and sequoia represented living fossils from the Jurassic Period? Who knows, but it's nice to think that these and the more recent Jurassic fossil tree additions would have appealed to his love of plants and geology.

Benjamin Hawkins' Frog

Dotted around the gardens are various sculptures surviving from Bateman's time including the Egyptian baboon god Thoth, two sphinxes, a wheelbarrow sized frog and a golden buffalo. These were all the work of Benjamin Waterhouse Hawkins (1807-1894), who famously created the dinosaur sculptures in the park at Crystal Palace for the 1851 Great Exhibition. In later life, Waterhouse Hawkins moved to America where he continued sculpting dinosaurs.

After the garden tour, we ate lunch in the old drawing room of the main house. Here some of the original Geological Gallery specimens, rescued from Keele University, were put on display. During the Gallery's restoration, natural history conservationist Nigel Larkin was commissioned to conserve the original fossils from Keele University and source new examples to create replicas for the Gallery walls.

The Geological Gallery

We visited the Geological Gallery after lunch and were given a guided tour by National Trust volunteer Barbara Kleiser. She explained the Gallery's history, the restoration works undertaken and guided us through each bay and the specimens on display. In creating the gallery, Bateman drew inspiration from scottish geologist and evangelist, Hugh Miller. He was also good friends with Sir Richard Owen (1804-1892), director of the London Natural History Museum. Owen coined the word 'dinosaur'. It may have been Owen that provided Bateman with many of the original specimens that were on display in the gallery. ►

Today, the gardens and Geological Gallery have, as far as possible, been faithfully restored to how the Batemans left them. Together, they act as a reminder of one man's dream to understand new ideas about our natural world and how these fitted with popular belief at the time.

Our group at Biddulph Grange

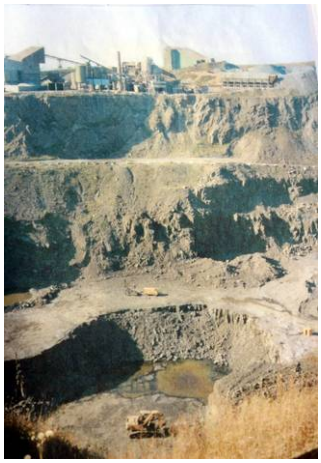
Our tour finished around 3.00. I would like to thank Brian, Adrienne and Barbara for a very interesting, memorable, educational and enjoyable weekend exploring both the Yorkshire Museum of Natural History and Biddulph Grange.

There is much to explore at both sites and further information about them can be found at: The Yorkshire Museum of Natural History website: https://ynhm.org/ and https://www.facebook.com/YorkshireNaturalHistoryMuseum/

The National Trust Biddulph Grange website: https://www.nationaltrust.org.uk/visit/shropshire-staffordshire/biddulph-grange-garden

Also, read Julie's article on Biddulph Grange, titled 'The Geological Gallery at Biddulph Grange Garden', BCGS Newsletter No. 251, October 2018. ■

Andy Harrison



Correction

In Newsletter 291, June 2025 we carried this photo which we thought was an early photo of Blue Rock Quarry on Portway Hill. We have since been advised by Mike Poulton that he has the same image with a caption: "Hailstone Quarry on the road from Tipperty Green to Turner's Hill - The road is no longer there". Mike Poulton has provided the Friends of Rowley Hills with many photos. Hailstone Quarry was another of the quarries in Rowley to the west of Blue Rock Quarry. Mike says: "It's one of Jim Rippin's photographs he passed on to me, although I'm not absolutely sure that it was Jim who took it." ■

John Schroder

The Wightwick Manor Erratics and an Erratic surprise at the Mount Hotel!

In the last issue *(Newsletter 193, October 2025)* I was able to bring you the story of the Wightwick Manor glacial erratics in the context of our involvement to help the National Trust with restoration of the boulders and up-date the interpretation for visitors to the property. You may remember that our research revealed that this array of erratics was originally collected by Charles Benjamin Mander around 1860 and put on display in the grounds of his home, the Mount, not far from Wightwick Manor. In 1952 the boulders were rescued and transferred to ►

The Mount Hotel, home of Charles Benjamin Mander from the mid-1860s

Plaque to C.B. Mander attached to the sandstone door surround at the Mount

Wightwick Manor by Sir Geoffrey Mander when the Mount was sold by the incumbent member of the Mander family and converted into a hotel, as it remains to this day.

After writing the article for the October Newsletter it occurred to me that we still had no idea whether Sir Geoffrey salvaged all of the original collection, or were some left behind at the Mount? If so, would any of them be there still, and would we be able to find them? There was only one way to find out!

I duly arranged to meet the hotel manager, Sarah Swain after sending her a copy of the BCGS October Newsletter article about the boulders at Wightwick Manor. Sarah said that she knew of one big boulder in the hotel grounds, but didn't know anything more about it, and seemed sure that no-one in the current team at the hotel knew the story of the boulders at Wightwick Manor.

The 'bouldery' with the Mount in the background

Pink Ennerdale granophyre erratic at the Mount

Sarah's clue put me on the scent and it didn't take me long to find 'the boulder', but imagine my surprise and delight when I discovered not just one, but about 10 boulders nestling around the base of a large conifer tree - surely the remains of the original C.B. Mander's 'bouldery'! *(See front cover photo.)* Some are quite small, but several are considerably larger than those at Wightwick Manor, with the tell-tale hallmarks of Criffel granite and Ennerdale granophyre (as at Wightwick Manor) confirming that these at least are genuine glacial erratics carried by ice to this area during the Devensian ice advance, to be dumped in their thousands as the ice finally receded around 11,000 years ago.

Sir Geoffrey's initiative saved the boulders now at Wightwick Manor, and we can only speculate why he left the others behind. It may be that these didn't fit in with the fairly uniform size scheme of the 19 boulders chosen for his display. It is now more than 70 years since the surviving boulders were abandoned at the Mount, but it is gratifying that they are still there as a feature in the beautiful grounds of the hotel. ■

More erratics in the 'bouldery' at the Mount

In the afternoon of 14 February we are hoping to explore the erratic collections at both Wightwick Manor and the Mount after the morning field visit to Smestow Valley. So far, the erratics at the Mount have not been seen by members of BCGS. We will keep you posted with further details when we have them. (Also see the Programme of Events, p.2).

Julie Schroder

Hebridean Gems: Iona (et al)

Iona *('I-thon' = 'isle of the waves')* is arguably the most famous island in the whole of the Hebridean realm thanks to the endeavours of a celebrated Irish abbot by the name of Colmcille, better known to history as St. Columba (AD 521-597). He founded the important abbey *(Fig. 1)* and is generally credited with the spreading of Christianity across Scotland and beyond. Less well known is the much older geological history of the island which begins with some of the oldest rocks in Britain, the Lewisian gneiss, and a fringe of younger Precambrian rocks along the eastern coast nowadays referred to as the Iona Group *(Fig. 2).*

Fig. 1: Iona Abbey with Dun I, at 100m, in the background

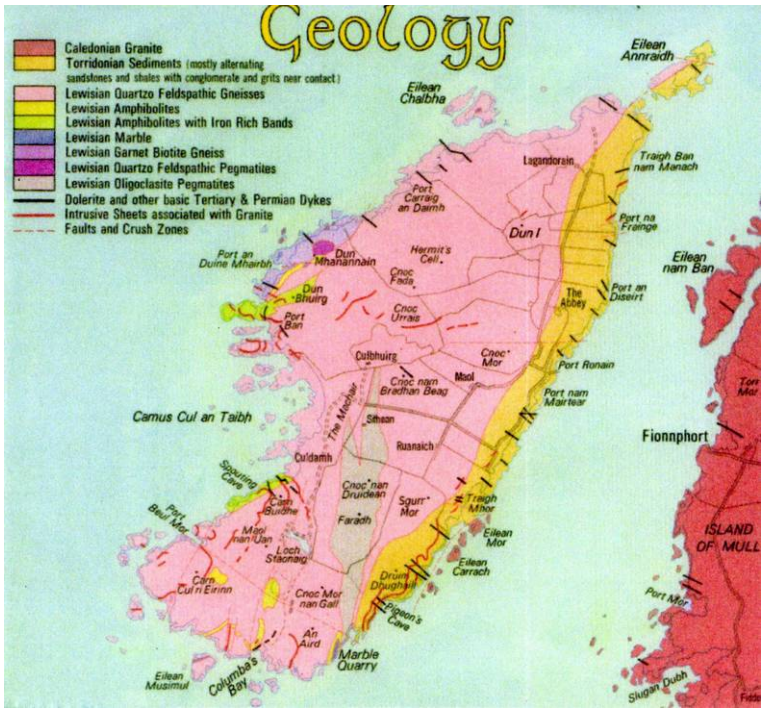


Fig. 2: One version of Iona's geology from 'Iona: A Map' copyright Iona Community 1983 (drawn by David Thompson)

In terms of infrastructure, apart from two roads which head off in opposite directions from the ferry landing point at Baile Mór (the one small settlement on the isle), and don't really lead anywhere specific, one might as well regard Iona as a place for the walker, and you won't be troubled by too many steep climbs. The highest point, Dun I *('hill Iona')*, is just 100m tall, seen in the background of Fig. 1, and is surmounted by a Kelsey pillar in lieu of the more familiar trigonometric column *(Fig. 3).* There is, however, plenty of rough ground if you choose to leave the network of well-worn tracks that zig-zag across the island. Since Iona is only five kilometres long and two wide, day trips are sufficient for many visitors. I've read somewhere that once upon a (geological?) time Iona was divided into two even smaller isles. A close inspection of the contours shows that this is rendered entirely plausible as a sea-level rise of just 20m would split the isle into two almost equal halves.

Fig. 3: The Kelsey Pillar and cairn atop a misty Dun I

Separated from its larger island neighbour, Mull, by a major fault that defines the Sound of Iona, their respective surface geologies couldn't be much further apart: Mull is for the most part a mere youngster by comparison. Indeed, Iona shares closer geological kinship with Coll, Tiree and the Outer Isles to the north-west, and to a lesser extent with Colonsay and parts of Islay to the south. Large faults divide this ►

part of the west coast into separate 'structural blocks'. These represent different terranes with contrasting geological histories. The Sound of Iona fault (SIF) is thought by many to be a continuation of the Moine Thrust (MT), separating more stable Lewisian foreland to the west from smaller Lewisian inliers that have been re-worked in much younger tectonic events to the east *(Fig. 4).*

Iona is widely considered to be a small fragment of the 'Coll-Tiree block', by virtue of similarities in the Lewisian basement rocks, of which Iona represents the southernmost outcrop in Britain. They are variously described as **biotite-hornblende orthogneiss** (having igneous origins and which are predominant), **paragneiss** (having sedimentary origins) or **amphibolites**. The paragneiss is confined to the west coast near Dun Mhanannain, and is probably younger than the orthogneiss. It includes biotite-gneiss, quartz-graphite marble, graphitic schists and garnet-bearing schists. The amphibolites *(Fig. 5)* occupy smaller, more widely scattered areas within the orthogneiss and include either serpentinite marble or iron-rich bands. They are derived from volcanic rocks, impure limestones and iron-rich chemical sediments ('banded ironstones'?).

At least six separate periods of deformation, four associated with the intrusion of basic dykes, have been described in these ancient rocks. You won't be surprised to learn that such details are difficult for the casual observer (like myself) to appreciate!

Fig. 5: Amphibolites of Dun Bhuirg (hill in background) near Port Ban

The angular isoclinal folds seen at Port Ban on the mid-west coast *(Fig. 6),* are probably an early feature, and were the only obvious small-scale folds I came across. The gneiss contains zircon crystals which provide formation ages of around 2,720 Ma *(Ma = million years).* Some whole-rock age determinations give slightly older dates of around 2,840 Ma, which are similar to ages from Coll and Tiree. Further kinship is suggested by a suite of amphibolite dykes common to both, correlated with the well known Scourie dyke swarm on the mainland of Scotland, dated to around 2,300 Ma. ►

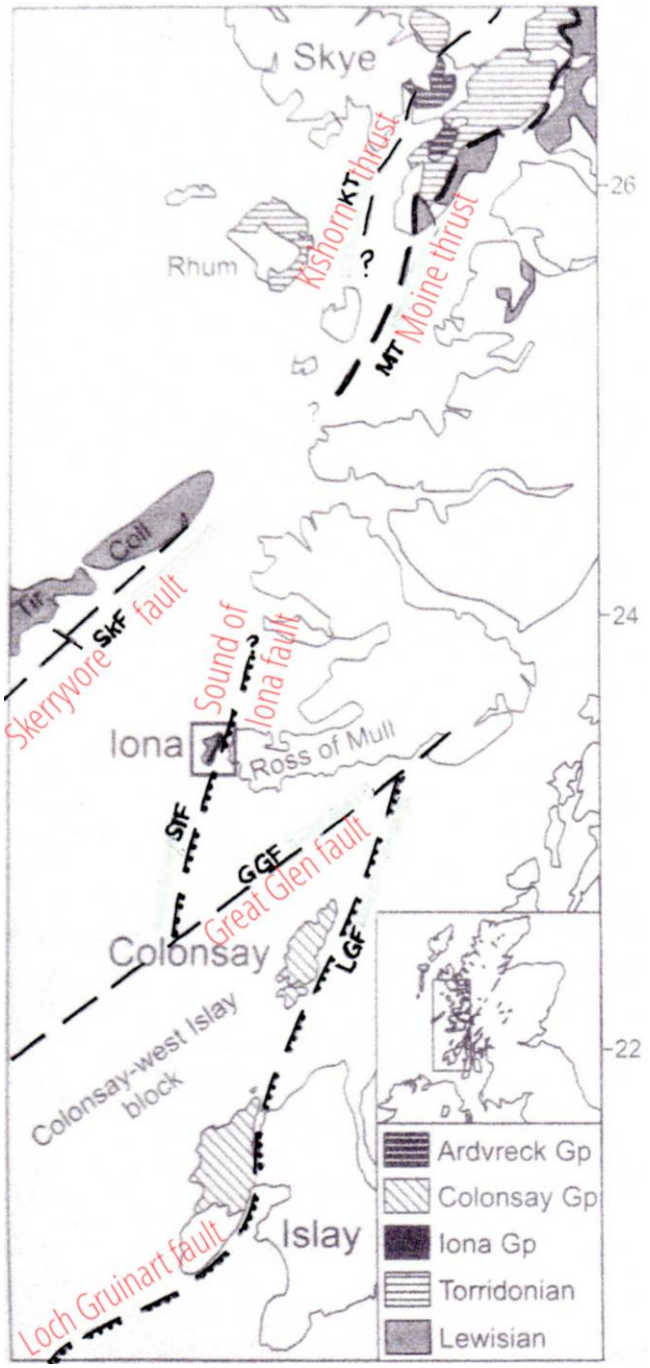


Fig. 4: Iona: in structural context (modified from C.A. McAteer et. al. Scottish Journal of Geology No.50, 2014

Fig. 6: Isoclinal folds at Port Ban

Another striking similarity between Iona and Tiree is the presence of small patches of marble. These are derived from limestone, a lithology not widely associated with such ancient rocks and more than likely having inorganic origins. Both occurrences are tiny in extent, but quite different in character. In-situ Tiree marble is pink in colour whilst Iona marble is white, pale grey, pinkish grey, black or green; the latter, tinted by serpentine and chlorite, is much prized by jewellery craftworkers. There are many scattered outcrops around the island; some seem like searching for a needle in a haystack. The main source is from the celebrated marble quarry *(Fig. 7)* east of An Aird, on the south-east coast, which is a marble with serpentinite associations. An altar table in the Abbey made of this marble is referred to by several visitors from the late 17th and early 18th centuries suggesting earlier exploitation, but the quarry was rediscovered in 1790 and worked intermittently thereafter until activity ceased around World War 1. There still remains plenty of evidence of past industry amidst a tumble of unused blocks of marble *(Fig. 8)*.

Fig. 7: Iona's celebrated Marble Quarry

Fig. 8: The cutting frame (et. al.) amidst a tumble of disused marble blocks

Fig. 9: The pale 'White Rock' (anorthosites) rising to Cnoc nan Druidean from Sithean (shown as Shian on 1:50,000 O.S. map 48)

Another oddity confined to the Lewisian of Iona and Tiree is the presence of bands of magnetite, bringing to mind that peculiar occurrence of magnetite-garnet schist on Tiree *(see Newsletter 271, February 2022).* On Iona they are apparently found associated with a final Lewisian rock type to look out for, variously described as 'White Rock', oligoclasite, pegmatite or anorthosite. This younger intrusive body follows a northward widening outcrop from the marble quarry, terminating in low crags near the dwelling of Shian (or Sithean). Seen from the road leading to the golf course *(Fig 9),* these crags stand out from the generally greyer gneiss, especially in sunny weather.

The Lewisian gneiss is unconformably overlain by a series of sedimentary rocks that form a 500m wide strip along the east coast of the island *(Fig. 2).* The best place to see the actual unconformity is at the northern end of Iona, opposite Eilean Annraidh (*Fig. 10).* These rocks were formerly regarded as part of the Torridonian succession (present to the north, on Rum and beyond), but now have the unique identity as the Iona Group because their exact correlation is more problematic. They have more recently been compared with either the Colonsay Group *(Fig. 4)* which is present on Colonsay and Islay to the south, or with the same part of the Dalradian succession on the mainland. ►

Fig. 10: Torridonian basement beds (conglomerates in foreground) just above the unconformity with Lewisian gneiss (background outcrop)

Whatever their true associations, the Iona Group is divided into an upper and lower unit. The lower beds consist chiefly of conglomerates and gritty sandstones (as befits a new, unconformable, cycle of deposition!) with some interbedded mudstones. Most of the clasts are from the underlying gneiss, while others of low-grade sandy metasediments have a less certain provenance. The upper beds are nondescript flaggy sandstones with shaly interbeds, the general succession suggesting an upward passage from alluvial fan deposits into prograding shallow lake deposits. All that can be said with any confidence is that the Iona Group was deposited sometime between 1,490 Ma (an age derived from constituent zircons) and 422 Ma (the age of the Ross of Mull granite which intrudes them).

One final rock type to look out for occurs as sheets and veins of red microgranite intruded into both the Lewisian and Iona Group. These are associated with the large Ross of Mull granite *(Fig. 11)* which forms the small islets just off the south-east coast of Iona. By far the youngest rocks to be found on Iona are lamprophyric dykes of probable Permian age *(Fig. 12)* and basaltic dykes of Palaeogene age; dyke swarms of both these ages are well-known on the mainland of Scotland.

Fig. 11: Ross of Mull 'red' granite on the nearby Mull mainland.

Fig. 12: Lamprophyre Dyke (Permian?), Port a'Ghoirtein Bhig, Iona west coast

As a footnote, whilst on the subject of Palaeogene rocks, this is perhaps an opportune place to mention two other small isles nearby off the west coast of Mull, with geology in complete contrast to Iona. The columnar basalts of Staffa, to the north-east of Iona, need little more comment, immortalised as they now are since Mendelssohn's visit and his musical evocation of Fingal's Cave. Bac Mòr *(Fig. 13)*, one of the Treshnish Isles to the north of Iona, has perhaps the most distinctive profile from which its more popular name derives: Dutchman's Cap. These are both part of the Palaeogene Igneous Province (basaltic lavas and associated rocks) and just a small part of the story of the opening of the North Atlantic Ocean some 60 Ma ago. ■

Fig. 13: A misty view of Bac Mòr (Dutchman's Cap) seen from Ardtun, Mull

Mike Allen

References:

BGS: British Regional Geology: 'The Northern Highlands' (4th Ed.)
C.A. McAteer et. al., 'Scottish Journal of Geology' No.50 (2014) p.143
'Iona: A Map', drawn by David Thompson (Iona Community 1983)
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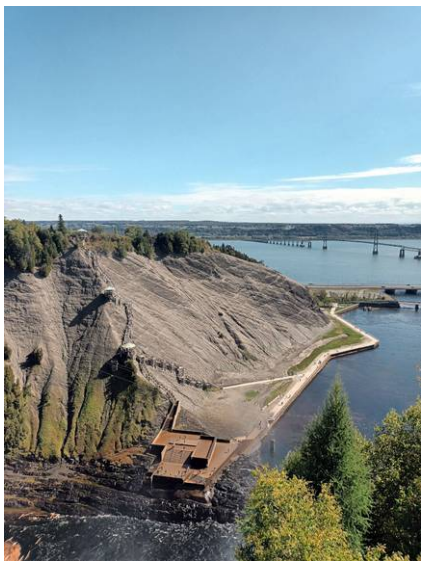
Parc De La Chute - Montmorency Falls

Quebec City's premier Geotourism site

The Heights of Abraham and the Hotel Frontenac may be Quebec City's most famous tourist sites, however, equally impressive (and visible from the city), is a magnificent waterfall some 12kms downstream. Discharging through a short gorge the Montmorency Falls are 30m higher than Niagara and discharge the significant volume of the Montmorency River into the St. Lawrence River.

Montmorency Falls, near Quebec City

Located on a fault boundary between the Precambrian Grenville terrane and Cambro-Ordovician sediments of the Appalachian Orogenic belt, the falls can be accessed by a gondola cable car system leading to a walk over a suspension bridge situated immediately above the falls. Then there is a descent down a steep path which zig-zags across the Palaeozoic strata. A visitor centre below the falls offers an excellent view of this spectacle and also the drop-off/hop-on point for the numerous transport links back to the city.



View from the top of the falls down to St Lawrence River, showing exposed Palaeozoic strata

Additionally, the falls lie just 80kms upstream from the Charlevoix Impact Structure. This eroded bolide impact site is estimated to be over 50kms in diameter and represents the largest of the 21 known astroblemes from the period. The partially exposed projectile, probably a stony meteorite, with an estimated diameter of 2kms and weight of 1.5 billion tonnes, has divided opinion on the actual impact date. Originally thought to have been from the late Ordovician 450 +/- 20 million years ago, an alternative date at the end of the Devonian has been postulated. The interesting point here is that both estimates coincide with mass extinction events associated with a cooling earth as would be expected after the 'nuclear winter' effect of such an impact (Hirnantian glaciation or Hengenberg anoxic event). ■

Mike Williams

Mike's Musings No. 60

So you think you know your granites? (Part 1)

Granite is one of the few igneous rock names with which the average 'man in the street' might be familiar. They may understand it in the meaning commonly applied in a commercial sense to any hard rock suitable for roadstone or similar 'aggregate' material. As a trade name it is often applied to other materials such as diorite, gneiss or even quartzite. Alternatively, they may associate it with the stuff that adorns their kitchen work surface or perhaps as a rock type found amongst the headstones in churchyards! ►

But I wonder what they would make of a definition taken from a geological dictionary such as: *"a coarse-grained acid igneous rock, sometimes porphyritic, consisting essentially of quartz, feldspar and dark (mafic) minerals which usually include micas or hornblende or both"* (Challinor's Dictionary of Geology) or: *"an important and widely distributed igneous rock; coarse-grained, mostly deep-seated or plutonic. It consists of quartz, orthoclase feldspar and mica..."* (Nelson & Nelson: Dictionary of Applied Geology).

Fig. 1: A fairly typical coarse-grained Cornish (Carn Menellis) granite. The largest well shaped crystals are of orthoclase (potassium) feldspar. The matrix contains mainly quartz, other feldspars and biotite mica.

Either of these scientific definitions would mean little to a novice without quite a lot of further elaboration to explain all the 'jargon' words involved. I don't wish to dwell too much at this basic level, but these remarks highlight how easy it is to 'lose your audience' without taking care to explain some of the technical terms as you go along. What, then, do we need to explain to clarify our understanding of the term granite in the strict geological sense?

We begin with what might seem to be self-evident, but even the term **coarse-grained** requires some further comment: ask 10 people to define it and you will probably get 11 answers (especially if they are geologists!), and sure enough there doesn't seem to be a consensus. However, a common sense approach suggests that an igneous rock will be regarded as *coarse-grained* if most of the crystals are larger than 5mm, and thus easily distinguishable to the naked eye *(Fig. 1)*. Another source suggests that *"in a granite, typically more than 85% of the crystals might be close to 1cm in size"*. Unlike the sedimentary world, which has a well defined grain-size classification system, I cannot find a similar scheme for use in the igneous world beyond one source defining <1mm as fine-grained, 1-5mm medium-grained, 5-30mm coarse-grained (coarser still, >30mm, and the term pegmatite is used).

Moving on, **igneous** rocks are those which have a molten origin i.e. from magma; and **acid** rocks are those which contain a high proportion of silica (SiO_2), usually quoted as being in excess of 63% (or 66% or ⅔) by weight. Note that, confusingly, the geological concept of acidity has nothing to do with the chemical notion of pH. ►

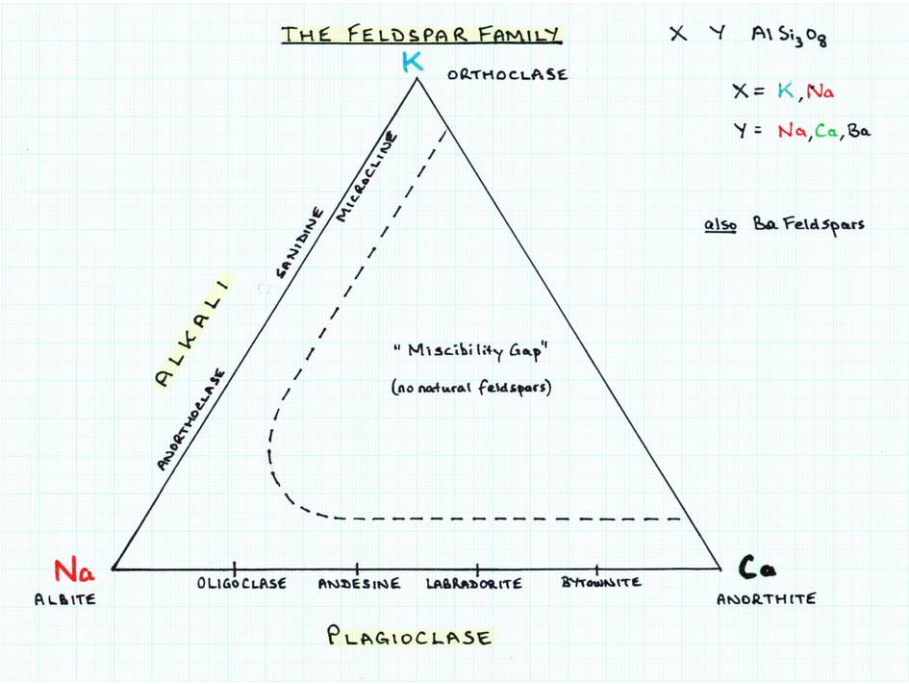
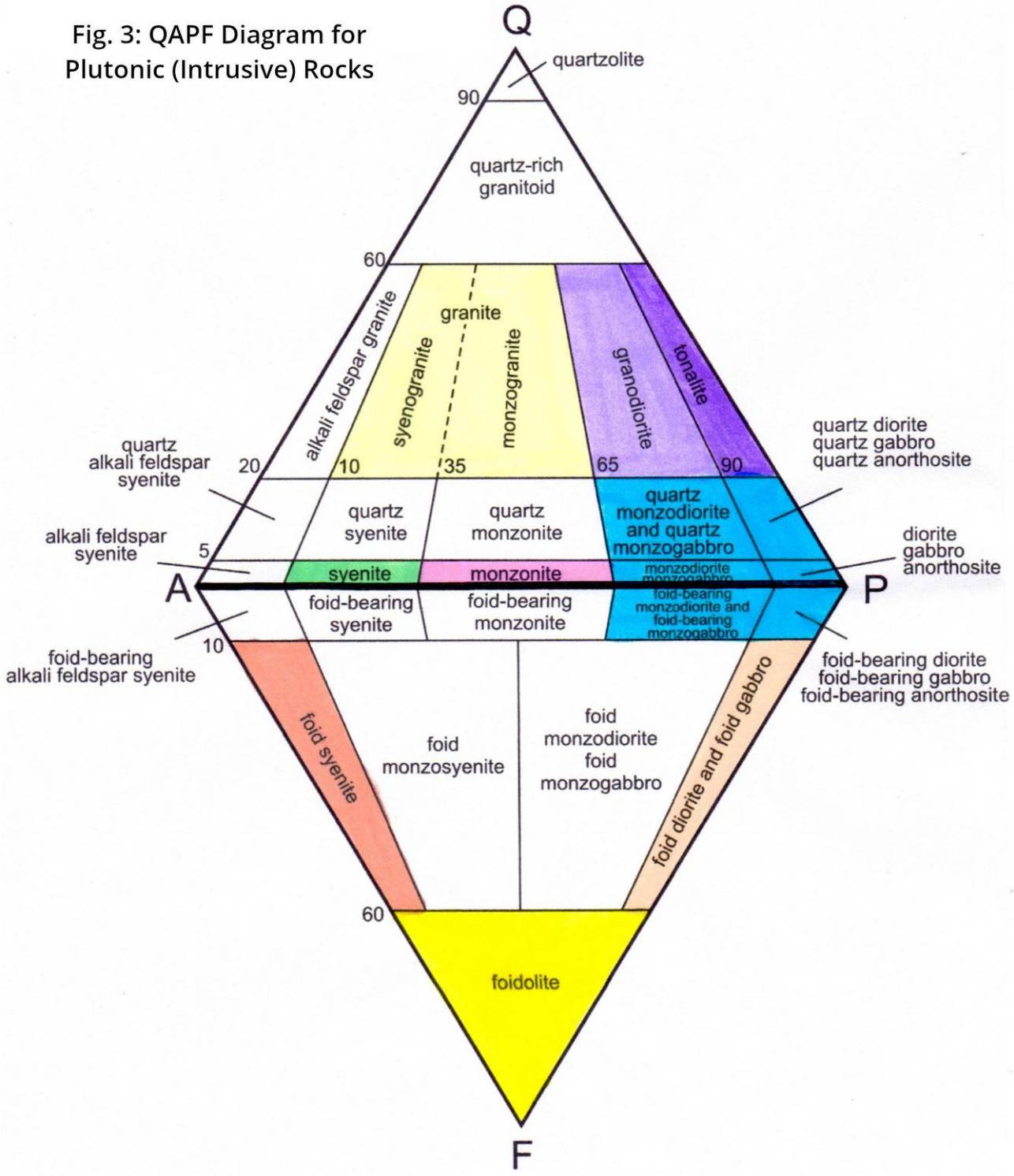


Fig. 2: The Feldspar family of minerals.

Plutonic rocks are those formed from magma cooling at depth rather than erupting at the surface in the form of lava. As for granites, their chemical composition often includes over 70% silica (SiO_2), around 15% alumina (Al_2O_3), and generally a relatively high proportion of potash and soda (K_2O+Na_2O total 5-12%), whilst their magnesium and calcium contents are relatively low (2-3% combined). With around 3% iron, there is then only room for further trace elements like titanium, phosphorus and manganese (each <1%). ►



Moving on to the mineralogical composition, the high SiO_2 content ensures that there is always free quartz present, and by definition in the 20-60% range. Note that while quartz is composed of SiO_2 (usually with some impurities), it doesn't account for the whole SiO_2 content of an igneous rock. As the above definitions indicate, the other principal mineral present is feldspar. What this simple statement fails to explain is that feldspar is actually a 'bucket name' for many minerals *(Fig. 2)*, which may be either a variety of alkali or plagioclase feldspar. Granite usually contains a bit of both. This provides for one means of discrimination between different types of granite. The modern way of illustrating this is in a so-called QAPF diagram for plutonic rocks *(see Musing 38, Newsletter No. 272, April 2022),* established by the International Union of Geological Sciences (IUGS) *(Fig. 3)*.

Granite is concerned only with the Q-A-P 'top triangle' of such a diagram, different types depending on the relative proportions of alkali (A) and plagioclase (P) *feldspar*, while containing 20-60% *quartz* (Q).

with:	>90% of the *feldspar* being alkali	= alkali *feldspar* granite	'granite sensu lato'
	65-90%	= **syenogranite**	**true granite**
	35-65%	= **monzogranite**	**true granite**
	10-35%	= granodiorite	'granite sensu lato'
	<10%	= tonalite	'granite sensu lato'

Only **syenogranite** and **monzogranite** (shaded pale yellow) are considered to be **true granites**. These names are derived from the fact that they grade into other rocks: **syenite** (shaded green) or **monzonite** (shaded red), having less than 5% quartz, via transitional identities with 5-20% quartz. The broader areas (white & purple) in the 20-60% quartz range are considered to be granites 'sensu lato' *(i.e. 'in the broadest sense')* and have the individual names shown. If the quartz content exceeds 60% there are two further areas given the names of **quartz-rich granitoid** and **quartzolite**: I don't think I have ever come across these in print other than on a QAPF chart! All this probably seems entirely academic; its main virtue is that it brings a little more definition to the naming of these rocks.

Fig. 4: Shap Granite (Adamellite or Monzogranite): Light (left) and Dark (right) varieties, both characterised by prominent feldspar phenocrysts.

Having said that, the above system actually fails to be entirely specific about the *feldspar* involved. It only refers to alkali or plagioclase types, without specifying the variety. However, these often follow naturally from the chemical composition. Thus, **syenogranites**, being enriched in potash and soda, will contain more orthoclase and soda-rich plagioclase (albite, oligoclase or andesine), while **monzogranites** being enriched in calcium will tend to contain more plagioclase, especially calc-rich bytownite, labradorite or anorthite) *(Fig. 2)*.

Now, just before you lose the will to live (!), you may like to test your skills at navigating your way around the QAPF chart to see where an **adamellite** fits. Although originally used to describe an 'orthoclase-bearing tonalite' from the Adamello Massif in Italy, it was subsequently used less specifically to describe a granite with roughly equal proportions of alkali and plagioclase feldspar, and no longer fits the rocks ►

which actually occur in the aforementioned massif (!!), perhaps explaining why this name has gone out of fashion. I mention this because the well known Shap Granite *(Fig. 4),* present on probably every high street throughout Britain, is technically an **adamellite** (now subsumed to a variety of **monzogranite**, and therefore sadly losing a bit of its former distinction as a more unusual rock type). Shap Granite is easily recognised by the very distinctive large, pink, crystals (phenocrysts) of orthoclase feldspar present, a condition described as *porphyritic* (a term introduced in the Challinor's dictionary quote above). It is applied to any igneous rock with a two-stage cooling history: usually an early slow cooling phase when the phenocrysts are formed, followed by a later rapid crystallisation of the residue.

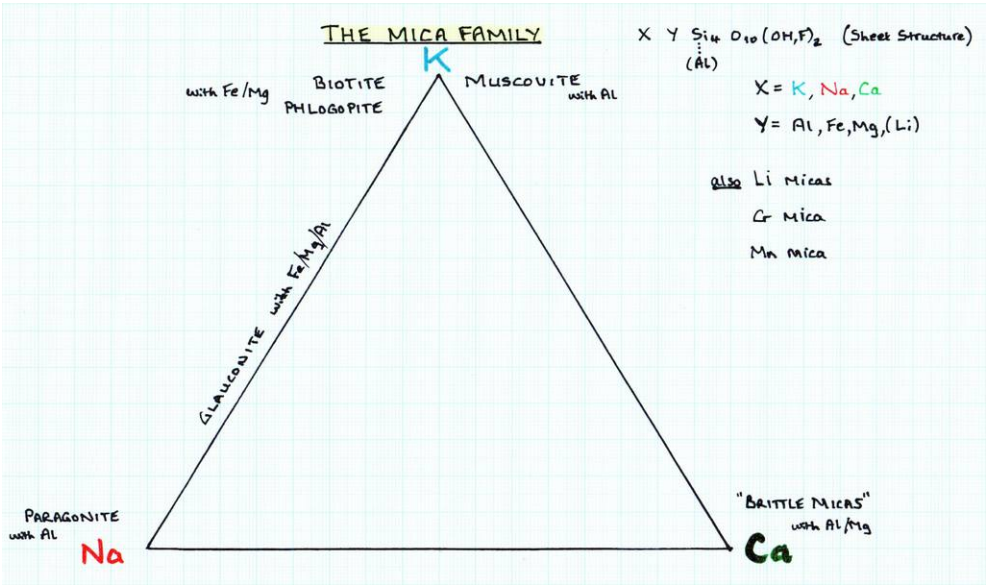


Fig. 5: The Mica family of minerals: mainly muscovite or biotite are present in most granites. (The main Lithium mica that occurs in some granites is Lepidolite.)

Having stretched your patience to the limit with the vagaries that *feldspars* have created, a consideration of the *micas* and the other dark constituents (*mafic*) of a granite will come as welcome relief in their simplicity. These minerals are used as a straightforward prefix to name a granite ('true' or 'sensu lato') more precisely.

Like *feldspar, mica*, is another 'bucket name' *(Fig. 5)*, and granites contain either one or two *mica* varieties. The 'white-mica' muscovite is often present in granites enriched in alkali elements (sodium and potassium), sometimes referred to as **leucogranites**. The 'dark micas' phlogopite and, more particularly, biotite, contain iron and magnesium and are more commonly present in **monzogranites**. It is not uncommon, therefore, to come across the more specific names muscovite-granite, biotite-granite or 'two-mica' (or 'binary') granite.

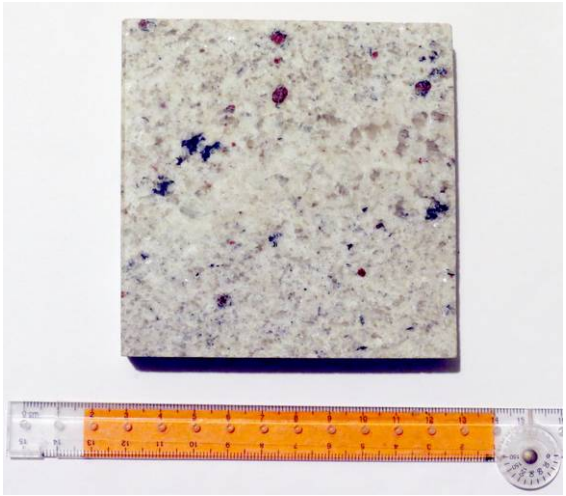


Fig. 6: Garnet Granite (actually a granulite from Kashmir!): the conspicuous reddish rounded crystals are garnets. The overall mineralogy is granite-like with quartz, feldspar and some mica and ?pyroxene.

The term *mafic*, which appears in the first quoted definition, refers to dark minerals rich in iron and magnesium, to distinguish them from pale, *felsic*, minerals lean in these elements (mainly feldspar and quartz). You will therefore appreciate that muscovite mica is *felsic* and biotite mica is *mafic*. Other *mafic* minerals that define specific types of granite include a pyroxene mineral (typically augite) and an amphibole mineral (usually hornblende). Whilst *mica* is always present and hornblende very often so, augite is present less commonly. You can therefore add hornblende-granite and augite-granite to the list of 'specified' granite varieties. ►

Some other minerals which may be present, sometimes in notable proportions, include, garnet *(Fig. 6)*, topaz *(Fig. 7)*, corundum, andalusite and tourmaline *(Fig. 8)*. The significance of these constituents will become clearer as we move on to consider other types of granite, and the various ways in which they may originate *(in part 2).* ■

Mike Allen

Fig. 8: Tourmaline Granite: from the St Austell pluton, Cornwall. This rock has undergone much alteration with both feldspar and mica replaced by schorl (the black variety of tourmaline, present as conspicuous bladed crystals). Quartz and some feldspar remains.

Fig. 7: Topaz Granite: from the St Austell pluton, Cornwall. Individual topaz crystals are inconspicuous to the eye, but are in part responsible for the yellowish colouration.

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