Dorset GA Group

Newsletter Summer 2021

https://dorsetgeologistsassociation.org/

Contents

Welcome to the Summer Newsletter!

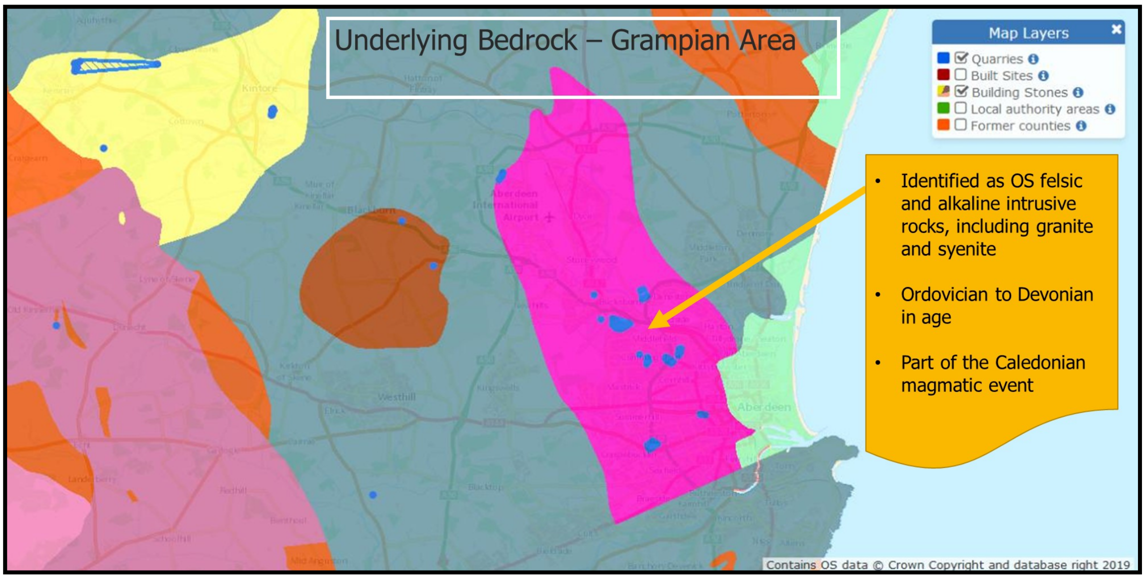
It was good to resume our field trips with the Weymouth visit in April and a transect across Dartmoor in May. We escaped the unseasonal May weather, notwithstanding a thorough soaking on Hay Tor! Val has put together a very good field trip programme and I am secretly hoping she can be "persuaded" to stay on for another year! (at least) I've continued to send out your weekly updates, which I hope you have found interesting. As we get back to some sort of normality, these may become monthly updates. I'm very grateful to all the Newsletter contributors who have kept this publication going during these unprecedented times. It also struck me recently that I've never heard from a large number of members so I am hoping, if you fall into that category, you might write something for the Autumn edition!

Kelvin

Local building stone

Sheri Karl provides this account of a very local field trip to Aberdeen during lockdown.

We started with the building stone of our house, easily identified as a granite but from where?

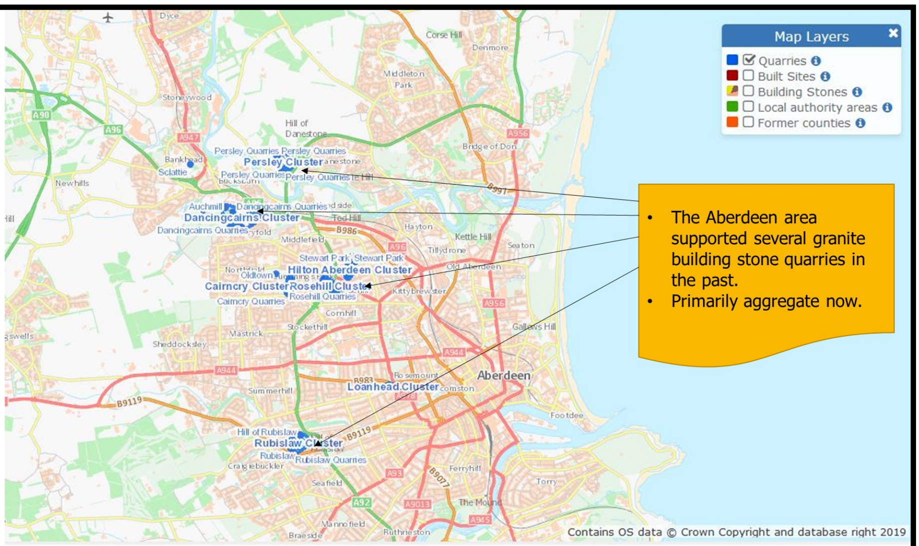


https://www.bgs.ac.uk/mineralsuk/buildingStones/database.html

Two Mica Granite

The image to the right is a close up of the granite building stone in a lightly weathered area of the house. The sample comes from a suite of granites in north-east Scotland that were intruded around 470 million years ago at depths of around 20 km. They were formed during the peak of metamorphism in the Grampian orogeny, which reached temperatures of 700 °C. There is strong evidence that the granites were formed by the melting of Dalradian metasediments, and they are surrounded by a high temperature, partially melted country-rock envelope. Many of the civic buildings in the local city of Aberdeen were built from this granite, which comes from the Rubislaw quarry.

Type: Igneous
Category: Granite
Rock-forming minerals: biotite, muscovite, mica, microcline and plagioclase feldspar, quartz.
https://www.virtualmicroscope.org/content/two-mica-granite-0



https://www.bgs.ac.uk/mineralsuk/buildingStones/database.html

The building stones commonly exhibit biotite-rich patches that represent the remains of a dominantly pelitic metasedimentary source. In thin section the rock exhibits large plates of quartz, intergrown with altered plagioclase and microcline feldspar. The microcline exhibits characteristic cross-hatched twinning. The rock contains many small fox-brown biotite grains with zircon inclusions, each surrounded by a pleochroic halo. Muscovite is present both as small grains intergrown with biotite and as larger plates.

Granite Building Stone - Types

Colour	**Pale**	**Intermediate**	**Dark**	**Very dark**
Colour/ composition / **Grain size**	**Silicic (silicon-rich)**	**Intermediate**	**Mafic (iron/ magnesium-rich)**	**Ultramafic (very iron/ magnesium-rich)** – none included in this selection of building stones
Fine (crystals too small to see, even with a lens) – none included in this selection of building stones			Basalt	
Medium (crystals visible, but need a lens to identify them)	Alentejo Granite		Dolerite	
Coarse (crystals easily seen with naked eye	SW England Granite Kemnay Granite Rubislaw Granite	Larvikite – Emerald Pearl Larvikite- Blue Pearl	Gabbro	
	Pale with pink feldspar			
	Balmoral Red Granite Shap Granite Ross of Mull Granite Imperial Mahogany Granite Rose Swede Granite Peterhead Granite Rosa Porrino Granite 'Baltic Brown' Granite			

Rubislaw Granite, Aberdeen, Scotland

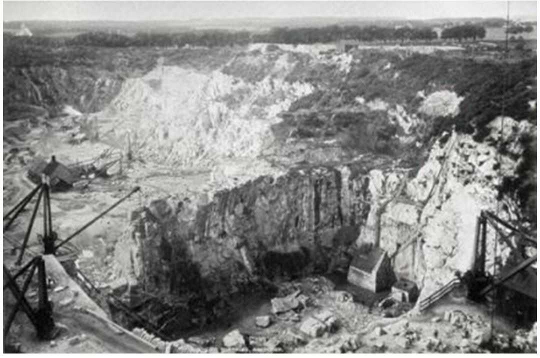
Rubislaw Granite with xenolith

Example outside of Aberdeen: Rubislaw Granite, Aberdeen, Scotland (Ecclesall Churchyard, Sheffield, 2012) Rubislaw Granite is another Caledonian granite and is similar to the Kemnay Granite, except that a higher proportion of dark ferromagnesian minerals results in it being a darker grey colour. It usually exhibits some foliation (alignment of minerals), resulting from a later phase of Earth movements.

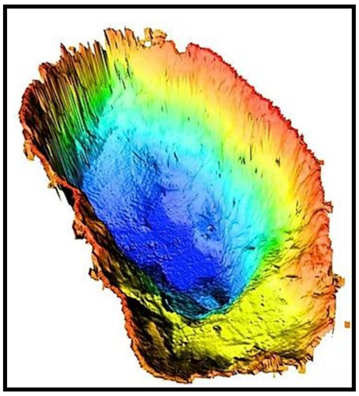
Rubislaw Quarry 1740-1971

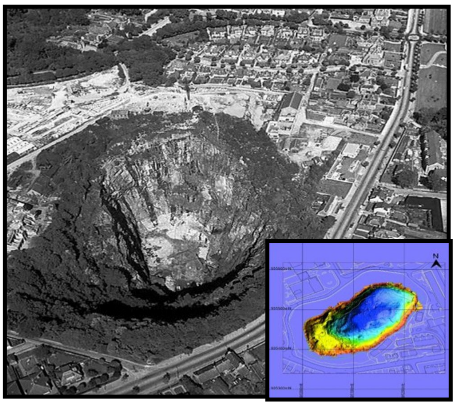
Rubislaw Quarry, circa 1880

When this quarry closed in 1971, it was some 450 feet deep. It had been worked for over 200 hundred years. Hundreds of thousands of tons of grey granite had been blasted and cut from the ground. In 1788, Aberdeen's Town Council had not been optimistic about the potential of the quarry and decided to give up its right to work the land. It has been estimated that at least 50% of Aberdeen's buildings are built of Rubislaw stone. Rubislaw also provided stone for the Portsmouth and Southampton docks. However, the depth of hole, the need to continually pump the quarry floor clear of water, poor stone and competition led to the quarry's closure. The hole remains spectacular despite filling



Rubislaw Quarry today





My morning walk takes a route around the perimeter of the quarry. It is fairly invisible except from the flats and commercial buildings round it.

Rubislaw Quarry Bathymetry Data (2012)
https://www.hydro-international.com/content/news/bathymetric-survey-of-rubislaw-quarry-completed

Aberdeen Art Gallery

Pillars of the local building stone granite are on display. A great place to visit to appreciate the variety of the north-east of Scotland bedrock.

***Alan Holiday* writes about his Interesting experience with an on-line field trip for London South Bank University students.**

For several years I have been helping with a Dorset field trip for LSBU civil engineering students looking at coastal management issues. Owing to Covid-19 this year, the March field trip was not possible. The lecturers at LSBU organised a local film company, Pageant Productions, to film four local geologists explaining the geology and coastal management issues. The locations were Lulworth Cove with Fiona Hyden, Lyme Regis with Richard Edmonds, Portland with Jeremy Cranmer, Weymouth Bay and West Bay with me. After a reconnaissance at each of the locations with Gary Jarman from Pageant Productions, we then had filming sessions in late February.

This was very professionally done, and Gary was excellent at learning about the geology as we went along. The weather wasn't brilliant but at least it wasn't raining! Not only was there filming on the ground but also use of a drone which provided some excellent aerial cover not normally available to the students on a standard field trip. The Weymouth Bay filming was at Redcliff, Bowleaze Cove, Furzy Cliff, Overcombe and Preston Beach Road. This provides very good examples of coastal management, such as ‘hold the line’ and ‘no active intervention’. Redcliff has excellent examples of rotational slip due to the combination of Corallian limestone over clay and sandstone. The section has been particularly active since 2016. The use of the drone produced some superb sections in the final version of the film. As the cliff top land has little value, nothing is being done to stop the mass-movement so this is a good example of ‘no active intervention’. At Bowleaze Cove, the Riviera Hotel was at risk of damage so in 1980 coastal protection measures were put in place with a gabion wall supporting the cliff as well as drainage and grading of slope to reduce the risk of landslips. Forty years on the gabions are still there but looking their age. However, they have done a good job for around £60,000! So here we have a good example of ‘hold the line’ in coastal management terms. In the final film version Gary included archive pictures to show how things have changed over the years and not just a 2021 view. Furzy Cliff, with Oxford Clay capped by Corallian sandstone, is another example of ‘no active intervention’ with rotational slip and clay flows. However, owing to beach replenishment further west on Preston Beach Road, shingle has moved eastwards and now helps to protect the base of the cliff from marine erosion. Overcombe and Preston Beach Road are good examples of ‘hold the line’ and where fairly dramatic improvements have occurred, helped by coastal protection schemes supported by the Environment Agency and the local council. I also covered the West Bay section with further excellent examples of coastal management contrasting East Cliff with the work carried out in 2004 and 2019 protecting West Bay from flooding.

Filming at Redcliff

Filming at Furzy Cliff

After the filming Gary did an excellent editing job so the students had four 3-hour sessions viewing the films and then having the opportunity to ask questions and make comments. It also allowed me to introduce more archive material to show how successful recent schemes have been.

***Jo Thomas’s article on Graphite in Cumbria drew these responses from** Roy Musgrove* ***and** Pete Bath.*

Roy writes*:* Jo Thomas's remarks in the Spring Newsletter on graphite provoke some additional considerations. The ridge dividing upper Borrowdale from upper Crummockdale (Fleetwith Pike) has Seathwaite "wad" mine on one side and Honister Slate Quarries on the other. Only one is metamorphic in origin; Honister "Slate" is a bedded tuff. Together they enlarge what can be seen of Lake District geology. There were four episodes of metamorphism affecting the Borrowdale Volcanic rocks. Because of the requirement for the presence of organics it is most likely that the last of these during the Acadian orogeny gave rise to the graphite.

By that time Devonian plant evolution would have provided generous amounts of organic material, which may or may not have been available during earlier episodes. The quantity and variety of form in the graphite made The Lakes relatively prosperous, because this small area was the only source of graphite in Britain.
Now the tuffs are water-bedded volcanic ash, and other evidence suggests that the Borrowdale volcanoes were low-lying and surrounded by lakes, which fits the tuff deposits. From knowledge of plant ecology, wetland areas in sub-tropical latitudes offer good conditions for botanical growth, perhaps destroyed in situ by a late volcanic episode, hence the source materials for the graphite. It does all agree, doesn't it?
On a meteorological point, the rain gauge at Seathwaite Farm is the wettest station in England and the miners walked to work and camped out from as as Keswick, and in a few cases even further. It must have been a miserable life. Historically fragments of Honister slate have been found at the Roman sites of Hardknott Fort and Ravenglass, so we know the rocks were already being quarried at the beginning of that millenium. The first written reference to the graphite mine is incidentally in 1643. Is it in the Bankes purchase documents for Kingston Lacy to which Jo refers? What I like about geology is the way a small outcrop can lead on to paleogeography, archaeology and history!

Pete adds this comment:

Doubtless in no time we'll likely be hearing from the National Trust; that although much of the Bankes family's wealth was long established on the mining of graphite from land they owned and acquired in Cumbria, that wealth was vastly augmented from interests in the West Indies. If they are bothered, they might also relate that with a French chemist's invention of a substitute for graphite in the production of gunpowder and some of Jo's listings, demand for graphite slowly fell away, whilst William Bankes was continuing to enjoy (to National Trust eyes?) an unjustified life-style of moneyed privilege. The National Trust tell me repeatedly, and although accepting that graphite is either a dry lubricant or pigment colouring decorative stone, that it is only of "niche" interest to anyone at all visiting Kingston Lacy. It is therefore not as important as the hidden ignoble fact that polished stones at Kingston Lacy were funded by colonialism and slavery. But I say - all Americans and British visitors to this house would do well to believe that geology and economic evolution matter too. The National Trust say in the media that they cater for all but in fact are now actively reducing their cognoscenti role and closing their minds and employment profiles to anything and anyone not to their minds mass-market - and that totally contrary to their statutory obligations. (Sorry - but my degrees were in Social Science/ Power Politics whilst in Geology - I have just a Continued Education Certificate).
William - doubtlessly innocent of the connection - falsely recorded that Kingston House had been designed by the architect Inigo Jones, not Roger Pratt and chose a very large tablet of Carrara Marble to tell his story of the House. The beauty and sensibility of his choice is plain for all to see, given that few kinds of stone have the tensile strength and hardness for production of such a large yet slim area of polished stone slabbing and the seriphed inscriptions still at least well gold-leafed by the National Trust. (I guess they think mere vainglory but nevertheless it is well looked after in comparison to compared to some not very visible exterior stone).
Also not then known to William, would have been the fact that his beautifully metamorphosed limestone, then known in the U.K. stone trade as dove-blue Carrara marble, was to be a most rarely seen and admired stone. It is as good as new, uniformly blue and dark bardiglio-veined, and both coloured and vein-patterned by the dissemination of graphite - the mineral on which his family wealth though not status was built. Almost another irony, from the point of view of polished stone naming, is that William's Italianate re-building of Kingston House boasts all common varieties of graphite patterning to be found in the varieties of Apuan Carrara white/blue/grey marble - smoky, smudgy Sicilian, linear-veined and bardiglio-patterned Carrara. Yet the significance escaped him and also the today the perhaps now untrustworthy National Trust company business.

Reference forthcoming: P. J. Bath, The Beauty of Kingston Lacy Stone, Private preliminary edition.

THE HOT ROCK SLOT

SERPENTINITES

Serpentinites are metamorphic rocks composed mainly of the mineral serpentine. They form by the hydrous alteration of olivine-rich rocks (i.e. peridotites, see the Spring 2020 Newsletter), particularly those comprising the upper-mantle parts of oceanic lithosphere. From the point of view of Earth processes, they are hugely influential in controlling the water budget of the mantle as they are one of the main vehicles by which water is transported down subduction zones.

Mineralogy:

Serpentine is a hydrous layer-silicate with a formula close to $Mg_3Si_2O_5(OH)_4$. The crystal structure is polymerised and comprises two types of sheet (Fig. 1): (i) laterally linked hexagonal sheets of corner-oxygen-sharing SiO_4 tetrahedra, and (ii) laterally linked sheets of $MgO_2(OH)_4$ octahedra, each of which share two oxygens with the apices of the tetrahedral sheets. The layer couplets have no net charge and are held together by weak hydrogen bonds, which accounts for the softness of serpentine (hardness 2½ – 3½ on the Moh's scale).

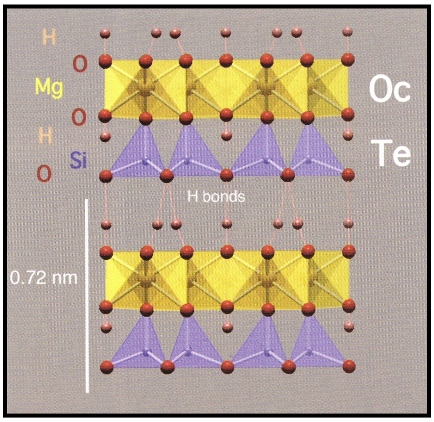


Fig.1.The basic crystal structure of serpentine showing the octahedral (Oc) and tetrahedral (Te) sheets. Diagram: B. Evans et al. 2013.

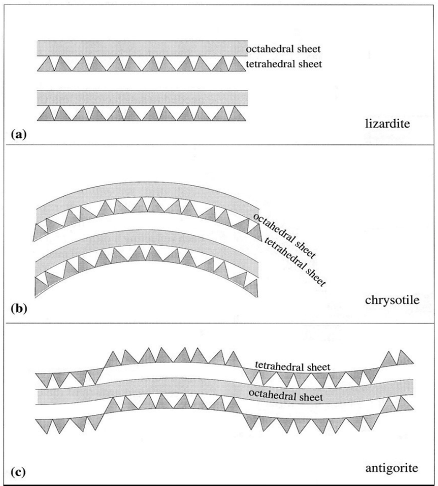


Fig.2 Structures of the three types of serpentine. Diagram: A. Putnis.

Within each layer couplet there is a size mismatch between the tetrahedral and octahedral sheets, the latter having a slightly larger along-sheet repeat. Intracrystalline strain can be relieved in three ways leading to the three main serpentine varieties (Fig. 2). In **lizardite** there is limited coupled substitution of AlAl for MgSi which reduces the size mismatch because Al atoms are smaller than Mg but larger than Si. Consequently, the layer couplets in lizardite are planar, and crystals generally tabular, though typically <u>very</u> fine-grained, as in 'mesh texture' (Fig. 3) which is characteristic of unrecrystallised serpentinites.

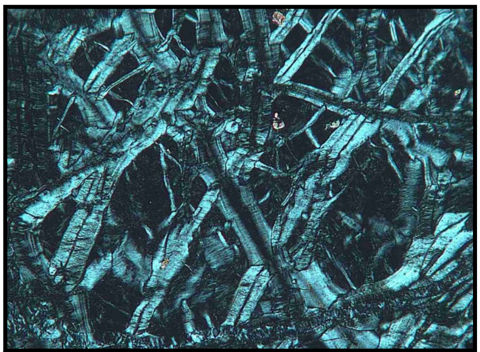


Fig. 3 Photomicrograph of lizardite showing typical 'mesh texture'. Crossed polars. Field of view 1.5 mm across. Photo: G. Droop.

In **chrysotile** the curved layer couplets are rolled up to form hollow cylinders (Figs. 2b, 4) producing a fibrous habit (Fig. 5); this is the most common form of serpentine in veins and is known as 'white asbestos'. In **antigorite** the curved layer couplets switch direction in a regular pattern resembling stacks of corrugated iron (Figs. 2c, 6) and its crystals have a flaky or tabular habit (Fig. 7). Antigorite is the high-temperature form of serpentine and is common in recrystallised serpentinites.

Serpentine minerals are usually greenish (e.g. Fig. 8) but impurities such as iron oxides may result in other colours. In the hand, serpentine has a greasy feel said to resemble that of snake-skin, which accounts for the name. Under the microscope, it is colourless or very pale green in sections of normal thickness (0.03 mm) but show characteristic bluish-white colours under 'crossed polars' (Figs. 3, 7). Minor minerals in serpentinites can include brucite ($Mg(OH)_2$), talc ($Mg_3Si_4O_{10}(OH)_2$), magnesite ($MgCO_3$), magnetite (Fe_3O_4), dolomite ($CaMg(CO_3)_2$), diopside ($CaMgSi_2O_6$), chlorite and tremolite.

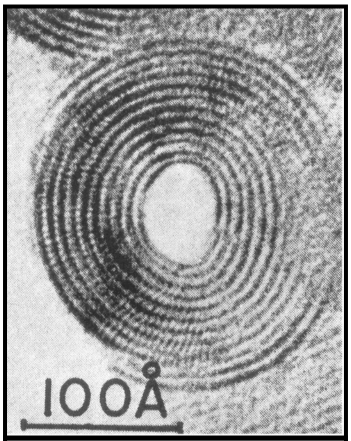


Fig.4 High-resolution transmission electron micrograph of a single chrysotile fibre. 100Å = 10nm. Photo: K. Yada.

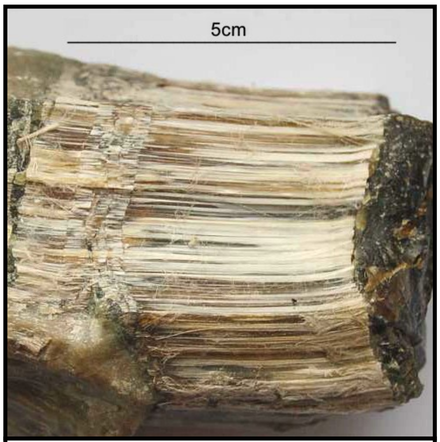


Fig.5 Hand specimen of chrysotile in a vein in lizardite. Photo: G. Droop.

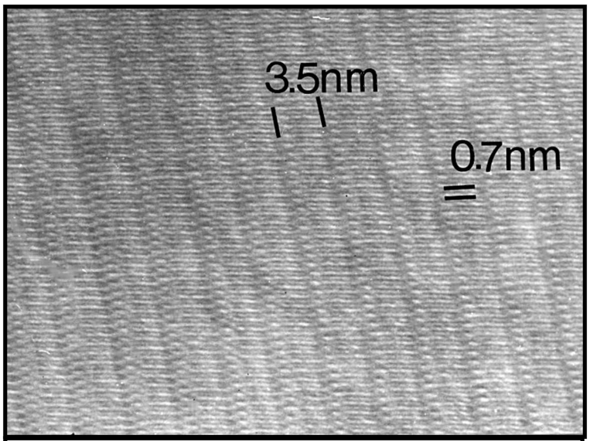


Fig.6 High-resolution transmission electron micrograph of a crystal of antigorite. Photo: R. Worden.

Serpentinite formation:

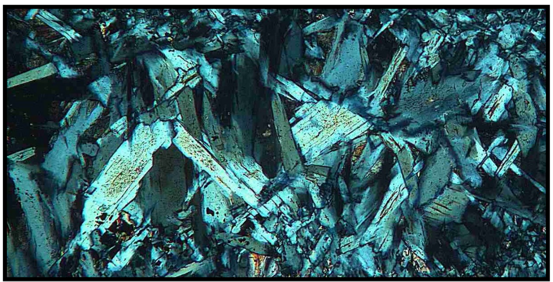


Fig.7 Photomicrograph of interlocking antigorite crystals. Val Malenco, N. Italy. Crossed polars. Field of view 1.5 mm across. Photo: G. Droop

In 1905 Gustav Steinmann, a German geologist, drew attention to the fact that serpentinites, pillow lavas and radiolarian cherts are often found together, an association that came to be known as the '**Steinmann Trinity**'. We now recognise these as components of ophiolite complexes, which we now know to be slices of oceanic lithosphere. The serpentinite–ophiolite connection can be explained as follows:

Near active ocean ridges, peridotites of the uppermost mantle encounter huge volumes of circulating ocean water in convection systems driven by magmatic heat. And in magma-starved oceanic lithosphere produced by slow-spreading ridges (as in the Atlantic), peridotites are commonly exposed on the ocean floor and can have direct access to sea water. Olivine is unstable below about 500ºC in the presence of water and readily reacts to form serpentine. If the circulating fluid contains enough dissolved silica, no other Mg-rich minerals need be formed:

$$\underset{\text{olivine}}{3Mg_2SiO_4} + \underset{\text{fluid}}{4H_2O} + \underset{\text{fluid}}{SiO_2} = \underset{\text{serpentine}}{2Mg_3Si_2O_5(OH)_4}$$

otherwise brucite forms as well. Many peridotites contain abundant orthopyroxene (opx), and this, too, can supply silica to form serpentine:

$$\underset{\text{opx}}{MgSiO_3} + \underset{\text{olivine}}{Mg_2SiO_4} + \underset{\text{fluid}}{2H_2O} = \underset{\text{serpentine.}}{Mg_3Si_2O_5(OH)_4}$$

Fig.8 Glacially polished exposure of antigorite serpentinite. Val Malenco, N. Italy. The white mineral is diopside. Photo: G. Droop.

These reactions have been written for the Mg-end members but the natural minerals contain some Fe as well. Upon serpentinisation the Fe is mostly oxidised to magnetite which, paradoxically, co-produces hydrogen gas. As a result, post-serpentinisation fluids are highly reducing; they also have high pH and calcium contents. Ca atoms are too large to fit in the serpentine structure so when opx (which typically contains minor Ca) is serpentinised the Ca ends up in the fluid. When these Ca-rich fluids encounter other rocks, such as dolerite dykes, they can chemically modify them by adding Ca (an example of **metasomatism**) to produce a type of calc-silicate rock known as **rodingite**.

Serpentine contains a great deal of structurally bound water: the four (OH) groups per formula unit translate to 13 wt.% H_2O. Thus for every km^3 of peridotite serpentinised, roughly 0.5 km^3 of sea water has been absorbed! In a subduction zone, all this can be potentially returned to the mantle. Because of its high water content, serpentine is much less dense than olivine (2.6 g/cm^3 vs. 3.3 g/cm^3); serpentinisation therefore lowers the average density of the oceanic lithosphere, which reduces the 'slab-pull' force in subduction.

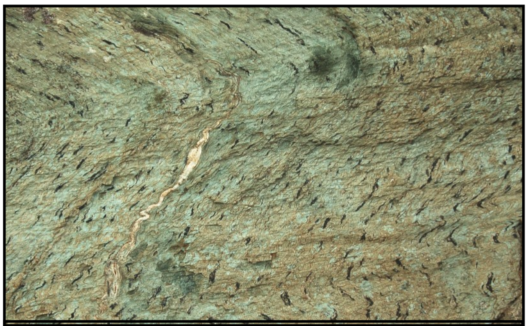


Fig. 9 Antigorite serpentinite with folded schistosity. Val Malenco, N. Italy. The black streaks are magnetite. Field of view ~20 cm across. Photo: G. Droop.

Serpentinite dehydration:

When caught up in continental collision zones, serpentinites can undergo dramatic heating and deformation. In the Alps, for example, most serpentinites have recrystallised to antigorite and many have developed tectonic fabrics (Fig. 9). If heated beyond *c*. 600ºC, antigorite breaks down to olivine + talc + H_2O, and at the highest grades of metamorphism peridotites are reconstituted. Sometimes the only evidence that a peridotite has been through a serpentinite stage is the presence of associated metamorphosed rodingites.

When oceanic lithosphere is subducted serpentinites can persist to great depths on account of the depressed temperatures in the downgoing slab. Ultimately, at a depth that depends on the thermal profile of the subduction zone (but probably in the range 100-200 km), the serpentine breaks down to olivine + opx + H_2O. The released water escapes and enters the overlying mantle wedge where it fluxes partial melting of peridotite, the process responsible for the development of volcanic arcs.

Uses of Serpentinite:

Serpentinites have been widely used as ornamental stones, often going by the name 'verde antique'. Massive varieties make excellent carving stones on account of their softness, as shown by the Inuit carvers of Cape Dorset, Baffin Island. Fine-grained pure lizardite can be translucent and has been used in jewellery.

Chrysotile, the fibrous form of serpentine, was widely employed for thermal insulation in buildings, heat-proof clothes, brake linings etc until its carcinogenic properties were recognised.

Fig.10 Weathered exposure of serpentinised layered peridotite in the Shetland Ophiolite. Hagdale, Unst. Photo: G. Droop.

Like peridotites, serpentinites contain appreciable amounts of nickel as a trace element. When subjected to prolonged intensive weathering in a humid tropical environment, thick deposits of a type of residual soil known as **nickel laterite** can build up in which Ni concentrations can exceed 3%. These constitute important ore deposits and account for >60% of global Ni supply.

Serpentinites are currently attracting interest as a potential medium for sequestering CO_2 on account of their readiness to undergo carbonation reactions at high temperature, e.g.:

$$Mg_3Si_2O_5(OH)_4 + 3CO_2 = 3MgCO_3 + 2SiO_2 + 2H_2O.$$

Geotechnical schemes involving carbonation of serpentinite mine waste are being explored, but whether they can be scaled up effectively remains to be seen.

Serpentinites in the UK:

Most British serpentinites occur in Scotland. Large outcrops form parts of the ophiolite complexes of Shetland (Fig. 10), Ballantrae and the Highland Border; these are thought to have originally formed parts of the floor of the Iapetus Ocean or associated marginal basin in the Lower Palaeozoic. Obduction probably occurred during the Grampian Orogeny when the Midland Valley Arc collided with the Laurentian passive margin in the Early Ordovician.

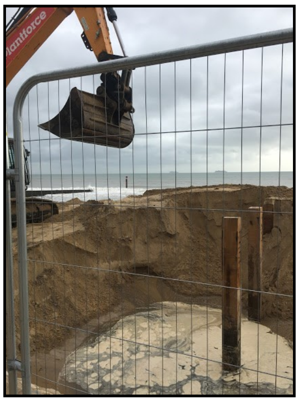
Smaller serpentinite masses of uncertain affinity occur in Glen Urquhart, Portsoy and elsewhere. In England, serpentinites are represented by the Lizard ophiolite complex of SW Cornwall, which originated in the Early Devonian as part of the Rhenohercynian Ocean floor; it was obducted as Armorica collided with Avalonia during the early phase of the Hercynian Orogeny in Middle Devonian to Early Carboniferous times. *Giles Droop*

Main source: Guillot, S. & Hattori, K. (eds.) Serpentinites. *Elements*, vol.9/2. 2013.

Mike Bowler discusses beach management in east Dorset.

Poole Bay Beach Replenishment and Groyne Replacement 2015-2032.

Work began in 2015 to replace all 53 timber groynes on Bournemouth beaches, along with several phases of beach replenishment. The project is expected to finish in 2032.
During the autumn of 2020 and early 2021, several groynes have been replaced along the west Bournemouth beaches between Middle Chine and the Bournemouth-Poole boundary. Rarely do



we get a chance to see how deep these groynes go below normal beach levels. It certainly made for a welcome distraction from the other things going on at the time. However, it did make social distancing more difficult, so not so many opportunities to monitor the work safely.
The depth of the groyne depends on how deep the substrata is below current beach levels, but the piles are 10m in length and typically driven 3m into the bedrock, but this varies according to the geology. The groynes are typically 75m long, and much of the work continues as the tide comes in.

Each groyne has between 200 and 240 "planks". These are like huge railway sleepers made from seasoned hardwood. The groyne replacement finished before March 20th and that area of the beach is now open once more to the public. More groynes will be replaced next winter to the east of the area, between Middle Chine and Bournemouth Pier.
Meanwhile, 7 depleted beach areas from Southbourne to Poole are being replenished, between January and the end of March 2021, although work may continue after the Easter break depending on weather conditions. Around 350,000m³ of sand and beach material is being pumped ashore which is then levelled to conform to the normal beach profile. Huge pipes, around 0.6m diameter, are attached to the pumps to the sinker-line (underwater pipe about one km in length) from the dredger which draws sand from the seabed in the bay along with seawater, making a "soup" that can easily be pumped ashore. Along the beach around 2km of the pipework allows different stretches of the beach to be replenished from a single junction with the sinker-line.

The beach between Bournemouth and Boscombe, "not quite as we know it"

I had not been able to get to Southbourne to see the first phase of the works due to Covid-19 lockdown travel restrictions, but the project is now moving west. I can legitimately get to the current area of replenishment for exercise so I can finally witness this phase of the project. The work on the beach below Bournemouth East Cliff, (between Boscombe and Bournemouth Piers) completed mid-March and the last phases this Spring are between West Cliff to Middle Chine.

This is where the groyne replacements referred to here have been taking place and around Shore Road in Poole, at the western extremity of the Bournemouth/Poole promenade. The left-hand image here is the three-way junction where the sinker line joins the beach pipework, and sluices determine which way the suspension is piped. There are sluices to direct accordingly.

"All present and correct, ready for deployment, Sarge!"

The phases planned before Easter will probably take place, as some of the pipes have been moved to the west of Bournemouth Pier.

Val Fogarty **reports on the urban field trip to Weymouth on Sunday 25th April**

Leaders: Alan Holiday, Kelvin Huff, Martin Gledhill, Val Fogarty and Pauline Dagnell

The original trip and booklet was devised by Alan Holiday over 10 years ago! Although the geology hadn't changed much, the names of the shops had and some buildings had disappeared completely! With this in mind, Alan, Kelvin and Val did a recce in September 2020 with a view to revise the booklet and rewrite some sections. We planned to do the walk on Sunday November 8th as part of the GA Festival of Geology when the Real Urban Geology Walks were planned, in different parts of the country by different groups. Members of DGAG signed up to come but then we went into another lockdown so it had to be postponed. Due to Covid restrictions this was our very first field trip in over 12 months! It did seem strange that we were separated from each other in small groups but that did allow everyone to hear their leader and ask questions as they walked this urban trail.

The weather was cool but dry as most of April had been. It was a popular trip with almost 30 people attending in 5 groups of six. We were very grateful to Martin and Pauline who acted as leaders as they knew the walk well, having acted as leaders with Sherborne Geology u3a a week earlier. The first group set off at 10 a.m. and the others set off at 15-minute intervals, keeping to Covid rules. Weymouth was quite busy, both in the eating area around the Old Harbour and in the shopping area, but we managed to weave ourselves through the crowds, observing the local geology.

We met at a monument to Thomas Foxwell Buxton, made of Portland Stone, on Bincleaves Green. He was a British politician and MP for Weymouth who campaigned for the abolition of slavery. It was easy to see the Weymouth Anticline with the Isle of Portland being on its southern limb dipping to the south whereas the rocks on the Ridgeway to the north of Weymouth, dipping north, included Chalk from the Cretaceous Period. The area between the two limbs of the anticline has been eroded, leaving the Corallian rocks which we observed on the trip. Working down the sequence and beneath the Kimmeridge Clay (that is found in Portland Harbour) were: Sandsfoot Grit, Sandsfoot Clay, Clavellata Beds, Osmington Oolite, Bencliff Grit, Nothe Clay and Nothe Grit. Further down and older still is Oxford Clay which is found below most of Weymouth. This clay that was quarried at Chickerell to make bricks. The promenade wall in Newton's Cove, made of Portland Roach, is very fossiliferous and very attractive with bivalves, including huge oysters showing their original colours and growth lines. It was built in 2003 but it is already showing signs of weathering. Looking back at the cliff towards Redcliff View, Corallian rocks, mainly Osmington Oolite, could be seen with the rock dipping gently to the south.

Bivalve in shelly limestone, Newton's Cove

On the walk towards Nothe Fort we walked on the promenade around Newton's Cove which has been well-constructed to prevent landslips. The Nothe Clay in the upper Nothe Gardens can easily slump when it becomes wet. We noticed the reed *Phragmites* growing in the Nothe Gardens, indicating very wet conditions.

A major slip occurred in 1987 so the promenade was built with its rock armour of Portland Stone. Nothe Grit makes up the ledges which were easily seen at low tide. Careful examination of the ledges showed trace fossil burrows of organisms such as *Thalassinoides* which was a crustacean, rather like a lobster that lived in the sediment of the sea floor in Jurassic times. Honeycomb weathering was also quite obvious in the ledges as well as jointing.

The walls of Nothe Fort are made of Portland Roach and we spent a long time looking at the vast quantities of fossils, including the 'Portland Screw', a coiled gastropod, and Osses 'Eads, the bivalve *Myophorella*. There was also Chert in some sections of the wall. We walked down to the Old Harbour and looked at the coast east of Weymouth, with excellent views from Preston to Purbeck, recognising the Corallian rocks near Osmington and the Chalk cliffs near Ringstead and Durdle Door. The Chalk figure of King George III on his horse could be seen on the Ridgeway above Sutton Poyntz as well as the Riviera Centre at Bowleaze Cove.


The 'Portland Screw', *Aptyxiella portlandica*

As we walked around the Old Harbour we could see further evidence of the unstable nature of the rocks as some of the footpaths had been closed and blocks of Corallian sandstone could be seen in the low cliff that had slipped and tilted as they had moved down over the clay. We walked up and down a flight of steps made of Jurassic limestone containing excellent fossilised stromatolites. My group were very excited to see them so clearly. These primitive marine organisms were the first living things to produce oxygen and without them life would as we know it would not exist. The air and the sea had no oxygen in it. They peaked about 1.25 Ga. and subsequently declined in abundance and diversity, probably falling victim to grazing protozoans. They were a type of cyanobacteria and produced food by photosynthesis with oxygen a bi-product. The stromatolites in these limestone steps are a mere 150 Ma. but the first ones on Earth were around 3.7 Ga.. Some types of stromatolites still exist in hypersaline lagoons in Western Australia, Chile, Brazil, Mexico and the Bahamas.


Stromatolites

We looked at the stone of Hope Congregational Church which surprisingly was made of Bath Stone whereas most of Trinity Church close to the Town Bridge is made of Portland Freestone. Bath Stone is creamy and slightly yellow. When observed through a magnifying glass the ooliths were clearly seen. As we walked through the town, once called Melcombe Regis, we saw that many of the kerb stones were made of granite containing phenocrysts, large crystals of the mineral Feldspar. We studied the plinth to a statue of Sir Henry Edwards on the corner of the Esplanade. John Scott pointed out flow-banding of the phenocrysts and the silvery mica flecks made of muscovite. This led to a discussion of how intrusive igneous rocks form. As we walked down St.Mary Street and St.Thomas Street, we looked at the facing stones of a number of shops. These were often made of igneous and metamorphic rocks.


Granite plinth showing flow-banding


Red granite, probably of Scottish origin

Larvikite, a very attractive black ultra-basic igneous rock, comes from Norway and is quite popular, with its 'Schiller effect', reflecting light off the cleavage surfaces. Quite a number of shops had granites of a variety of colours. Examples of metamorphic facing stones were a biotite-mica-schist and a phyllite. The high street banks were built mainly of Portland Stone although Lloyds was built of Ham Hill Stone, with its characteristic shelly, oolitic appearance and cross-bedding. This is caused by sediment being deposited by current action on an inclined surface following a short period of erosion. The Ham Hill Stone was paler than often seen and contained a large number of calcite veins.

The Dripping Well

The Rodwell Trail follows the track of the former Weymouth to Portland railway. The trail rises as you walk from the low-lying Oxford Clay (160 Ma.) onto the more resistant Corallian strata (155 Ma.) of Rodwell and Wyke Regis. We saw tufa limestone which had been deposited as calcium carbonate-rich water had seeped out next to Wyke tunnel. The gently south-dipping Corallian strata were noticed in the cutting as well as springs forming the famous Dripping Well. The water comes out at this point because of the permeable sandstone and limestone strata being inter-bedded with less permeable clayey layers. Alan Driscole can be seen here holding a cast of a *Myophorella* that he found on the Rodwell trail in the Clavellata (formerly Trigonia) beds .

We had lunch in Sandsfoot Castle Gardens where a Henry VIII castle is situated. Or should I say its remains, as some has slipped into the sea! At the present time you cannot enter it at all as it is such a hazard. We walked down onto the beach, passing the cliff next to Old Castle Road that has recently been secured to reduce the chances of further mass-movement. I believe three, luxury, detached houses are going to built by the beach. It is a beautiful setting but it is shocking that anyone would consider building so close to the sea! The Western Ledges were apparent as it was low tide and these are made of Osmington Oolite, part of the Corallian group. At the back of the beach, the Clavellata beds were seen, with many *Myophorella* fossils. The raised tubercles on the outer part of the shell strengthened it in the turbulent sea water where it lived. We took a path up from the beach which took us back to Redcliff View.

It was a very enjoyable and interesting field trip. A huge thanks to Alan Holiday and Kelvin Huff for planning the route and producing the detailed booklet. If anyone would like a copy of the booklet do get in touch with Val Fogarty by email.

Two articles follow covering the use of loupes in geology

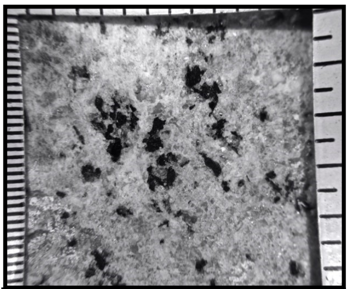
Dorset Building Stone group member *Pat Snelgrove* writes:

Looking at stone through a loupe is much easier than using a pocket magnifier. Loupes are cheap to purchase on the web. I bought two loupes about 4 years ago. They are still in use regularly and cost under £10 each, currently with a case. I would recommend one as essential equipment to anyone who goes on field trips. Using the loupe with a camera is an extension of its use and a practical way of recording a surface for later inspection or to pass on to a colleague for their opinion. Over the past year I have used loupe photography to help identify or confirm the identity of building stones. Many of my loupe photographs went to Geoff Townson for identification. I have not found it particularly easy to get good loupe photographs to include in descriptions on the Dorset Building Stone website, particularly where the stone is smooth, as the camera needs something to focus on. Weathered surfaces are good as long as they are not completely covered by lichen or, in the case of church fonts, old whitewash. I use two pocket cameras, both equally adequate. They are Panasonic DMC TZ40, now at least 5 years old, and a Sony DSC-HX90 which I bought last year.

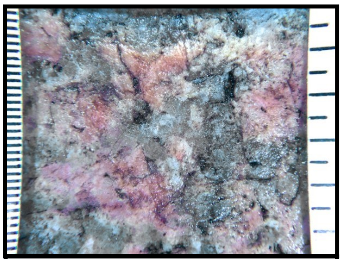
Pete Bath, also a DBS group member, says:

"Treat yourself to an LED Magnifier"

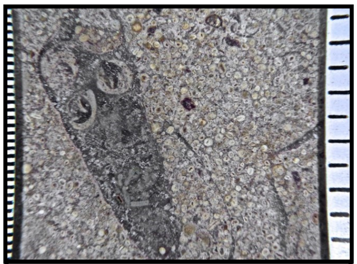
Everyone has a favourite hand lens but even the very best Zeiss is limited to available ambient light, so the x 3 LED lights built behind both metric and imperial scaled graticules in these aids to circuit board repair, can be of great assistance to adults and children too. Here are four views of both hand specimen beach pebbles and of building stone, but any reachable exposure can be seen in very good light. As previously described these simple little instruments are used by DBS website contributors to provide evidence of stone ID via pocket cameras. However, they are mostly used, all the time, just to choose the best image of whatever stone or natural rock is the subject of interest. LED light is normally violet-hued but except for photographic images these hand loupes reveal accurate dimensions and colouring to both grainstone and crystalline textures of any rock free of algae or lichen.



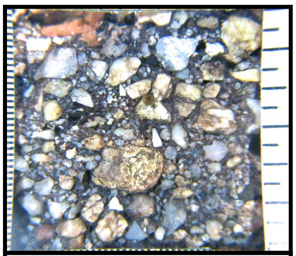
Donegal white granite. *dry*



Donegal Bloody Foreland granite. *wet*

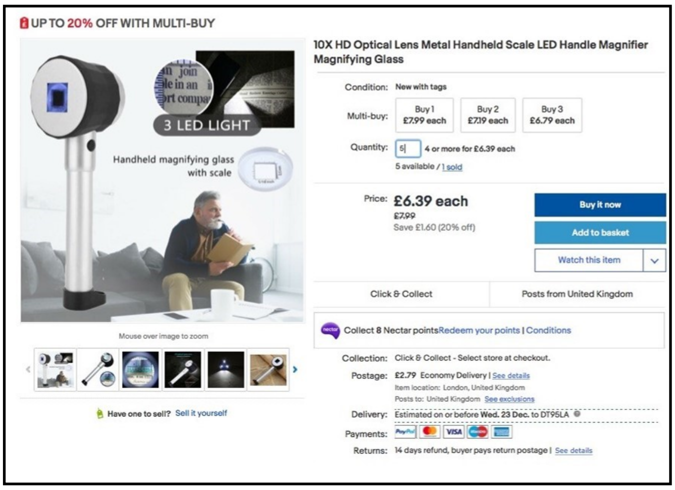


Marnhull Corallian Oolite. *dry*



Studland Heathstone. *dry*

Occasionally this Chinese version and a Japanese model (3 times the price and with heavier, rattly batteries) can be found on Amazon. I have found reliable sources in mainland China, Hong Kong and you may also try Taiwan. This one below is in London and Manchester has been a local source too. They are found on eBay using combinations of these words: 10x /x10/ hand held/hand-held/handheld/LED/loupe/jeweller/ jeweller's/jewellery/magnifier/magnifying/scale/ scaled - hence the difficulties often finding any at all in the U.K. But once you find one in the U.K. - then many similar titles will be listed below from China.



If you first make a U.K. search and there is still one there they will appear at the top of the screen and nearly all others currently available from China and Taiwan will be listed below. Postage charges from these countries are at or below ours. The goods might be labelled sample, gift, or whatever the senders think the most economical. Some units are less violet in their colour tone but you get nowhere asking for white light or a lighter violet hue, given none are marked by the makers themselves. (The Japanese models have their manufacturer's details imprinted on them.) C'est la vie.

To the eye, this instrument allows you to see any well exposed 20mm x 20mm square of rock, stone or anything within your focus, set within a fixed graticule scale. A well-fitting front camera lens to the eyepiece allows images to be made that include all or some of the scaled graticule. DBS folk use the metric graticule scale to visually determine if presumed ooids are in fact ooids or other orbicular grains, including sand. Determining the preponderant size and shape of sand grains and what percentage the various shapes and sizes amount to, allows you to confirm the identification of your image.

The expert petrologist may not need this tool but it must raise the standard of regular users' differentiation between any clean rock or stone. (and for that matter people interested in lichen and algae too.)

Alan Holiday **provides us with this masterclass on:**

Unconformities

An unconformity is a break in the geological succession of varying length. The time gap that is represented is termed a hiatus. It represents a period when there was no sedimentation or a period when sediment was deposited and then eroded prior to a second sedimentation event.

1. Weathered lava flow, Hawaii

It can be represented by a weathering surface as you might see on the top of a lava flow (picture 1) or where there are recognised soil horizons as in the Purbeck rocks (Late Jurassic and Early Cretaceous) of Portland and Purbeck, Dorset (picture 2). Theoretically a bedding plane is a type of unconformity, but it represents a very short time gap. The term unconformity is normally applied to longer breaks in the succession. Therefore, an unconformity may represent a major geological event which could have global implications, but some unconformities are very minor. For example, in Shropshire in an area of around 2 km^2 seven unconformities have been mapped within the Cambrian sediments.

2.Palaeosol, Portland, base of Purbeck Beds

Three different types of unconformity have been recognised in the Grand Canyon, U.S.A. with heterolithic, angular and parallel types (see below for definition).

Unconformities are caused by local or regional uplift of land masses which may involve folding (orogenic, as in picture 3) or not (epeirogenic), fluctuations in sea level which may be linked to plate tectonic processes e.g. ocean ridge development is thought to have caused the major marine transgression in the Cretaceous to produce the Chalk (picture 4). This caused large areas, that had been land, to become continental shelf sea. Climatic change can also influence environments of deposition and sea level with a sea level fall if a major glacial episode occurs over a land area e.g. during the Permian glaciation which affected north Africa.

3. Unconformity on Kerrara with ORS over Dalradian

4. Ringstead unconformity: Late Cretaceous over late Jurassic sediments

An unconformity can therefore be described in terms of time but also in terms of non-deposition or erosion of rock material. Although unconformities are normally seen in a cliff as a two-dimensional feature it should be remembered that they are planar and extend laterally over very large areas although they may be covered by younger rocks. They separate a group of older rocks from a group of younger rocks. The surface may be 'flat' if it was an erosion surface on the sea floor when water depth was limited, and so current action prevented deposition. The erosion surface may be very irregular if it was a land surface that was subsequently buried by younger sediments e.g. the Torridonian Sandstone covering the Lewisian Gneiss in north-west Scotland.

5 . A minor unconformity in Permian sediments, Paignton

Sometimes the beds above and below the unconformity have the same dip and this is described as a **parallel** unconformity (picture 5). The rock above the unconformity may also be horizontal or gently dipping while that below dips at a different amount, in a different direction or may be folded. This is known as an **angular** unconformity e.g. south of Paignton in Devon where the gently dipping Carboniferous/Permian breccio-conglomerates rest on more steeply dipping Devonian slates and limestones (see picture 6 on next page).

6. Paignton: unconformity with Permian over Devonian mudrocks

7. Barry Island unconformity: Triassic over Carboniferous Limestone

It can also be seen at Barry Island (south Wales) where the nearly horizontal Triassic rests on top of the dipping Carboniferous Limestone (picture 7). A **non-depositional unconformity** occurs if there is a brief period of non-deposition and can be recognised only with detailed study e.g. through missing zone fossils or epibole, (when a species reaches its peak development) a term first initiated by Buckland in the 19th C. A bored surface with rolled fossils might also be present or oyster (*Gryphaea*) encrusted bedding planes which probably represented a wave-cut platform. Examples occur in the de la Beche unconformity at Vallis Vale, Somerset (picture 8). Washouts may also occur as are often seen in Coal Measures strata e.g. in south Wales near Saundersfoot, or an intraformational conglomerate due to pene-contemporaneous erosion (picture 9). This is deposition and then erosion of the bed very soon after, followed by rapid deposition as seen at Freshwater East in south Wales in Upper Silurian strata. The term **heterolithic unconformity** has been coined for a situation where younger sediments rest on top of igneous or metamorphic rocks which have been exposed at the surface due to weathering and erosion, so the example given above of the Torridonian Sandstone on top of the Lewisian Gneiss in north-west Scotland would fit this category. A buried landscape is a form of heterolithic unconformity.

A number of terms have been defined to describe the relationship between the rocks on either side of the unconformity. **Overstep** is used where a younger series of beds rests on progressively older beds. This will occur in some situations with a major marine transgression due to a rising sea level causing sediments to be deposited on top of rocks which have been folded or tilted. **Overlap** occurs when progressively younger beds rest on an older series, the latter doesn't have to be folded/tilted. This again will result from a marine transgression event. **Offlap** occurs when there is a marine regression and the younger series occupies a progressively smaller area. (Other terms such as non-conformity and disconformity have been coined but are synonyms for other terms and should be ignored.)

8. Oyster-encrusted erosion surface at Vallis Vale

An unconformity can be recognised by a variety of evidence. An angular unconformity can be identified by measuring the dip and strike of the beds above and below the unconformity. The difference in dip may be quite small as between the Black Ven Marl and Blue Lias at Lyme Regis, Dorset, which is covered by the Upper Greensand and Chalk. The difference in dip is a matter of 5° or so but represents a time gap approaching 100 million years. Also, the difference in angle of dip may vary from place to place according to the disposition of the folded strata below the unconformity. As there may have been a very large time gap there may be a significant difference in sediment type, degree of compaction. induration and metamorphism of the two groups of rocks. It should be realised that there may appear to be an angular unconformity, but it isn't really, e.g. when a younger series of horizontal rocks rest on cross-bedded sediments of which only a small exposure is available for study (picture 10).

9. Evidence of localised erosion at Wiseman's Bridge, Pembrokeshire

10. Close-up of cross-bedding at Enard Bay, Assynt

11. The Siccar Point unconformity

12. Ercall Quarry: Wrekin Quartzite over Precambrian volcanics

With a heterolithic unconformity the fact that there is igneous and/or metamorphic rocks in the lower sequence suggests that these have been affected by an orogenic episode. For example, the famous Siccar Point unconformity in southern Scotland, first recognised by Hutton around 1805, has nearly horizontal Devonian sediments resting on vertically-dipping Silurian slates and greywacke sandstones, the folding and metamorphism being a product of the Caledonian orogeny (picture 11).
Other evidence for unconformities can be found through fossil evidence which provides relative dating of the rocks above and below the unconformity. Also, radiometric dating may be used for igneous and metamorphic rocks as well as some sediments. For example, if a dyke intruding sediments is cut by the unconformity, the earliest date of the unconformity can be identified. The sediments above the unconformity may be coarse clastics if the sea level rise was rapid or if sediments were deposited in a continental facies. It might be possible to recognise the rock types from which the pebbles are made as at Paignton where the clasts in the Permian sediments are made of Devonian limestone fragments with fossils. If the sea level rise, associated with the marine transgression above the unconformity, is slow then a mature quartz arenite (ortho-quartzite) often develops e.g. basal Cambrian in Shropshire - Wrekin Quartzite (picture 12).
In the early 1970s scientists recognised that some unconformities may have world-wide significance. This was realised from study of seismic data collected during petroleum exploration programmes. Seismic reflection profiles could show breaks in the succession and these could be recognised in widely spaced locations. They could be due to synchronised orogenic episodes but far more likely widespread marine transgressions. These could be related to increased volcanic activity along oceanic ridges. With higher heat flows they take up more space, displace sea water which then causes a rise in sea level by as much as 500m. Similarly continental collision reduces ocean ridge volume and results in a fall in sea level. The marine transgression at the beginning of the Cambrian and during the Cretaceous could be explained by this plate tectonic process.

Another great 'masterclass' by Alan. Is there a geological topic you'd like to know more about? Perhaps you'd like the basics of a topic explained ? Let me know and we'll do our best to oblige! *Kelvin*

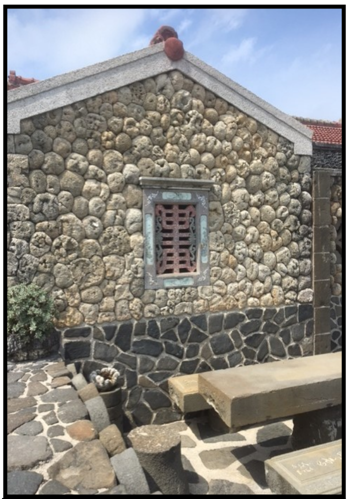
Geological snapshots from Taiwan

Members *Alison and Adrian Neil* have family in Taiwan, and Alison provided some pictures from a recent visit. Alison says: Here are a few photos of our visit to Penghu islands, not great quality as I took them with my phone.

1.Flying a kite over a stone pier on a windy and cloudy day.

2. A basalt arch formed when sea eroded the supporting sandstone and the basalt above collapsed. The formation is said to resemble a whale.

3. Street in a half abandoned village with a fine carved basalt window. There were wooden shutters inside for colder weather.



4.House in the same village with a wall made from rounded corals.

5.The cabins (in the distance) where we stayed on Wang An island. The view is north-east, where the wind and lots of marine rubbish blows in from.

6. Wangankou Beach, Wang An island. This is one of 6 protected green turtle nesting sites. There was only one other person on the beach when we were there.

7. Basalt columns forming a cliff. There are other more spectacular ones in the islands, but this was a short walk from where we stayed.

8.The hotel (middle house) at Shanshui Beach back on the main island where we stayed the last night, with old fishermen's houses in front, not yet redeveloped.

9. Shanshui Beach, mostly deserted out of season

10.Chen Chen and Jia Wei spent the morning making a sandcastle, and managed not to fight!

I couldn't resist adding a map to this section as I was curious about the location! The Penghu islands have the oldest volcanic geology of Taiwan as a result of the collision between the Indian plate and Eurasian continental plate, and the subduction of the Pacific plate after the late Mesozoic. *Kelvin*

Editor's notes

1. Why not do a talk on *your* geo-holiday at our Holiday Rocks event? Do let me know if you can.
2. I have 2 green, DGAG-branded polo shirts (medium) for sale along with 3 sweatshirts - 2 medium and I large. Price is a donation to DGAG funds! Do contact me if you are interested.

Kelvin

DGAG Field Trips and allied events 2021-22

N.B. All events and field trips are subject to current Covid rules and restrictions

To book a place on our field-trips, contact Val Fogarty using her details below. £2.00 day trip fee.

June 26th: Portishead. Leader: Alan Holiday

July 25th: In the Footsteps of William Smith. Leader: Martin Gledhill

August 14th: Inferior Oolite near Sherborne. Leaders: Bob Chandler and John Whicher.

Black Country Residential Field Trip, 3rd-6th September, based in Dudley. Leaders: Graham Worton, Andrew Harrison and Noel Donnelly.

October 9th: Undercliffs Reserve near Axminster.

Leader: Geoff Rowland

If any member has any ideas for field-trips please let Val know.

As temporary Events Officer I have booked Broadmayne Village Hall for the following events:

October 23rd: Holiday Rocks: Speakers t.b.c.

December 11th: Winter Workshop

January 8th 2022: A.G.M.

https://dorsetgeologistsassociation.org/
https://dorsetbuildingstone.org
https://dorsetrigs.org/

DIGS (Dorset's Important Geological Sites)

The group welcomes anyone wishing to help with conservation work on Local Geological Sites. Please contact Alan Holiday if you are interested. Working parties go out on both weekdays and weekends.
alanholiday@btinternet.com

Wessex OUGS events

Please contact Jeremy Cranmer on: wessexdaytrips@ougs.org or telephone 01305 267133 to book a place. £2.50 day trip charge.

All OUGS Wessex fieldtrips have been postponed until further notice.

Can we help answer your geological questions?

Either post them on our website's contact form or send them, maybe including photos, to me at the email below.

Kelvin

Reminders: Contributors' deadline for the Summer Newsletter is: **Monday, September 6th, 2021.**

Committee news:

We **still** need an Events Officer (not a very onerous job at the moment!)

Kelvin

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