Dorset GA Group

Newsletter Autumn 2019

https://dorsetgeologistsassociation.org/

Contents

Welcome to the Autumn Newsletter!

In this issue we have a number of field reports and regular features. We also have Part 5 of Pete Bath's monumental (no pun intended) Kingston Lacy series and details of our annual dinner (application form inserted). Thank you to all contributors. I'm sure you will be aware that our Chairman, Alan Holiday, underwent heart surgery recently and is now recuperating at home. I'm pleased to report that Alan is recovering well and it shouldn't be too long before we are struggling to keep up with him on one of his field-trips! *Kelvin*

DGAG at Lyme Regis (see p.6)

DGAG in windy South Wales

South Wales Field-Trip: Saturday 4th May Locality 2: Dunraven Bay

Dunraven Bay provides the opportunity to study Lower Lias sediments. On arriving, we stopped at the small display area to find that the *Gryphaea arcuata* specimens had, sadly, been robbed. Crossing the impressive storm beach, we walked north-west and found chert-rich beds with potholing in the wave-cut platform. The Blue Lias sediments exposed here belong to the Southerndown Member which passes into the overlying Porthkerry Member. This is marginal facies, deposited close to the shoreline. Finds of fossil wood confirmed this near-shore sedimentation. Winnowing of fine –grained mud has left clasts of Carboniferous chert behind. The rocks of the Southerndown Member are comprised of lithoclastic and bioclastic sands and gravel-grade conglomerates. The conglomerate contains a lower proportion of limestone lithoclasts and has higher clay content. These occur in thin beds. In the upper part of the Southerndown Member, we saw patches of ooliths and some crinoid remains. There is alternation between mudstones and argillaceous limestones. These are on a centimetre to decimetre scale. As the exposures were studied, it became clear that the cliff changes from a limestone- dominated succession to a succession where there is a greater proportion of mudstone. This trend continues eastwards to Nash Point, evidence of a marine transgression or basin subsidence.

Winnowed chert clasts

We then walked south-eastwards towards the Trwyn y Witch headland. Here, the Sutton Stone conglomerate lies unconformably over folded Carboniferous Limestone. Sutton Stone is a shoreline deposit equivalent to the Porthkerry Member. Formed over a span of 2.7 Ma., it contains rare ammonites and feeding traces. A spectacular section shows the E-W trending Dunraven fault, a reverse fault active during the Alpine inversion of the Bristol Channel basin during the Miocene Period. The fault and associated fracture zone were seen clearly, the rocks having been up thrust by 30-35m. Small anticlines and synclines were noticed at the base of the fault zone in as well as drag folds, shearing and slickensides. Clearly, there were many phases of movement. To the south of the fault, we saw the thick Sutton Stone draped over a Carboniferous Limestone platform. Above the Sutton Stone were the thick, bedded limestones of the Southerndown Beds.


The Dunraven fault

We walked back toward the slipway, studying the Lias exposures. The Lias section consists of thick limestone beds with thin shale beds between. There were many fossils and some of the beds have a distinctive fossil content including corals and brachiopods and occasional reptile bones. There is a large variation in the fossil content, with some beds having up to 50%, (mainly as bioclastic debris). Bivalves are especially important, with *Plagiostoma* and *Gryphaea arcuata* (the Devil's Toenail) occurring in large numbers at some levels and sometimes in nests. The bivalve *Pinna* was seen in its life position, often in section. Ammonites also occur and are used for providing relative ages for the formation. We spotted ammonites in the wave-cut platform, fossil wood plus bioturbation with *Thalassinoides* burrows.

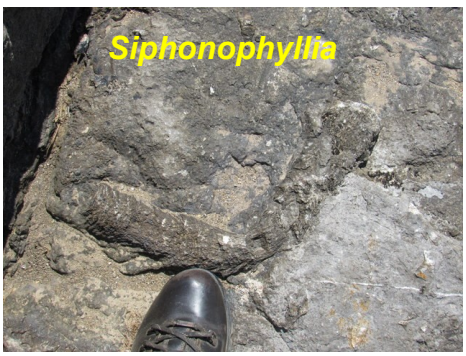
Locality 3

After a refreshment stop at the Heritage Centre, we walked to the Nant Cwm-Mawr viewpoint above Dunraven Bay on the south side of the headland. There were impressive views to the south-east towards Nash Point, comprising gently folded and faulted cliffs and rock platforms of Blue Lias. This coastline is subject to quite rapid coastal erosion and has many frequent cliff falls. The scale of the Holocene erosion was emphasised by the height of the hanging valleys of Cwm Bach and Cwm Mawr.


View from Nant Cwm-Mawr

Locality 4

We then drove back towards Ogmore to study the Bwlch y Gro and Black Rock areas. Here we saw a third Triassic debris flow lying unconformably over Carboniferous Limestone. Further along a cliff section showed the Sutton Stone overlying the Carboniferous Limestone. Sutton Stone is only found in South Wales. It consists of white, conglomeratic limestones with pebbles of black chert and Carboniferous limestones, laid down in early Jurassic times. The bedding-plane surfaces in the Carboniferous Limestone contain solitary corals such as *Zaphrentis*, *Caninia* (now re-named *Siphonophyllia*) as well as colonial corals such as *Lithostrotion*, *Michelinia* and *Halysites*. *Productus* brachiopods, crinoid remains and feeding trails were also seen on a richly fossiliferous surface. The bedding planes show the results of the Dinantian storms of the Lower Carboniferous.


Siphonophyllia


Lithostrotion


Colonial coral squashed flat!

The corals seem to have been bent over by a storm event and then continued growing with pinch points well-displayed in some specimens. There is evidence of more mineralisation, including barytes with galena and calcite plus tension gashes. Walking eastwards we saw a stepped unconformity between Carboniferous and Triassic strata and the possible base of a sea stack on a Jurassic erosion platform.

The ‘Jurassic cliff’ has corals replaced by barytes. Stylolites were also well displayed in the Sutton Stone, as well as some bivalve shell fragments. A Carboniferous stromatolite was seen near the steps back to the road. On the way back to the cars we saw a small exposure of the Southerndown Beds to finish off an excellent day. Report and photographs by *Kelvin Huff*

South Wales Field-Trip: Sunday 5th May : Lavernock Point and Bendrick Rocks

Sunday was spent studying coastal sections between Lavernock Point (south of Penarth) to St Mary’s Wells Bay and Bendrick Rock (between Sully and Barry Island). I have visited Barry Island on several occasions, but these two sections were new to me. We approached the first section via a narrow country lane past the Marconi Holiday Park leading to Lavernock Church (Kelvin had arranged to park in the church car park). The Marconi Holiday Park is so named because Marconi sent the first radio message across water from Lavernock Point to Flat Holm, an island 4 km to the SE, in 1897. There was then an easy walk down to the beach. I was immediately struck by the tidal race flowing past as the tide was falling. Visiting Severn Estuary sites normally requires a falling tide, preferably a spring tide and the tide times are similar to the Dorset coast although the tidal range is very different!

This section is important as it exposes the boundary between the Triassic and Jurassic in vertical cliffs and shore platform. Care has to be taken as rock falls occur. Structurally the strata are gently dipping with small flexures generating a gentle anticline to the north and syncline to the south. We initially walked north a short distance towards Ranny Bay where we could see evidence of the red and green Triassic strata formerly known as the Tea Green Marl now Mercia Mudstone (Blue Anchor Formation). Above this is the Westbury Formation (Rhaetian, Penarth Group). In the cliff where we first gained access to the beach, we could see the distinctive ‘pink band’ which occurs towards the base of the Blue Anchor Formation. The sequence is made up of varying proportions of limestone and shale, initially shale dominated but further west moving up the succession limestone dominates. We found many loose blocks of interest on the beach with the fauna dominated by the oyster, *Rhaetavicula contorta*. There was also a nice specimen of symmetric ripples suggesting a lagoonal environment of deposition. In late Triassic times this was an area of low topography with lakes/ marginal marine or lagoons with hypersaline conditions on occasions resulting in some gypsum deposits in the sequence. Salt pseudomorphs can also be found but not on this occasion. We also found loose blocks with evidence of pyrite (rusty) and bone fragments with what might have been a fish tooth.


Late Triassic mudstones and limestones

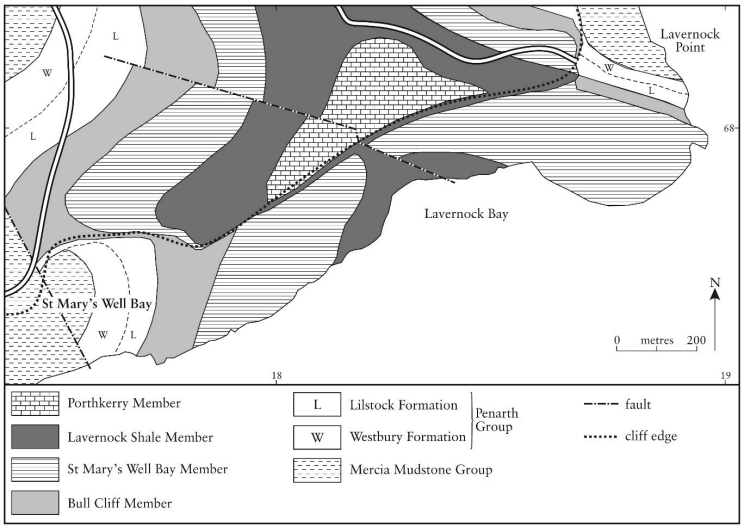

Symmetric ripple marks


Dessication cracks

As the blocks were loose it was difficult to determine their exact provenance. As we worked west, we moved up the sequence into the Westbury and Lilstock Formations of the Penarth Group which includes the Cotham Member. This unit has some impressive mud cracks which are very deep (30 cm). Further west we moved up into the base of the Jurassic (Hettangian) where a double limestone bed marks the base of the Jurassic. This section was the source of the dinosaur specimen we saw evidence of during our visit to the Museum of Wales. Paper shales are exposed, and these contain *Psiloceras planorbis*, the earliest ammonite in the UK. We were informed by John however, that two earlier *Psiloceras* species have been found in Austria! (We are always unlearning long held knowledge!!)

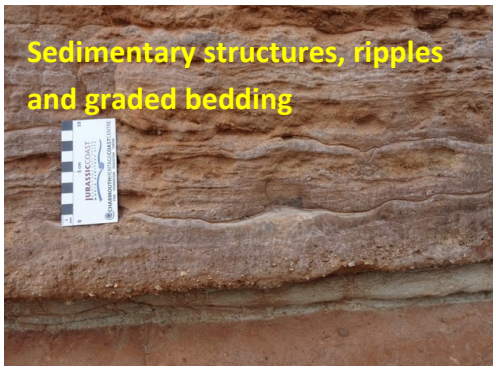

Possible *Echioceras*

This also shows a change to fully marine conditions and to confirm this we saw other ammonites and some crinoid debris. This represents a gradual marine transgression at the top of the Penarth Group and base of the Jurassic. Towards St Mary Wells Bay the strata dip to the east so we were working down the sequence again. Just before we left the beach, we saw evidence of the Lavernock Fault with an estimated throw of 160 metres (see map below).



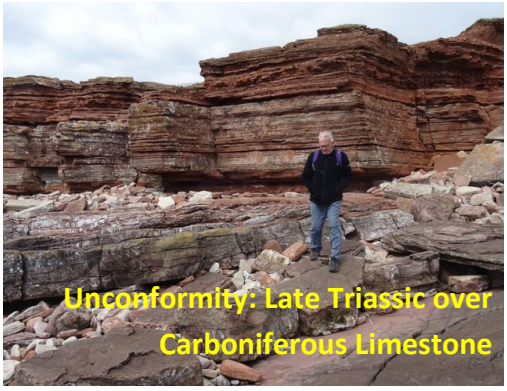
Following the return walk via the coast path we moved on to the Bendrick Rocks site where late Triassic sediments have a variety of dinosaur and archosaur footprints on gently dipping wave cut platform surfaces. *Anchisauripus* is the generic name for some of the footprints. The non-dinosaur basal animals were part of the archosaur clade. The footprints are numerous, and it is thought that they are of five different species (G.C.R. volume 24, also source of the map left).


A worn footprint


Sedimentary structures, ripples and graded bedding


Prominent fault

There are also plant stem structures with burrs around the site of plant stems. The fauna consisted of both herbivores and carnivores, so plants were essential! Within the Triassic sediments there are some gritty beds with graded bedding suggesting they were deposited by fluvial action during storm events. Ripple marks were also seen in vertical section. Another feature seen were numerous small cavities in the rock where gypsum was deposited, subsequently dissolved away and the space partly filled with calcite. Well developed desiccation cracks also provided evidence of the fluctuating conditions when the Triassic sediments were deposited. Another important feature at this site is the angular unconformity between the horizontal Triassic strata and the gently dipping Carboniferous Black Rock Limestone.


Unconformity: Late Triassic over Carboniferous Limestone

The latter is red-stained from the effect of groundwater passing down from the Triassic red beds. John pointed out the weathering of the limestone surface from Triassic times where the rock surface has flaked due to intense heating (over 40^{o}C) and the evaporation of groundwater. Within the Black Rock Limestone there was an interesting mineral vein with zoned margins linked to movement of groundwater along the fracture. The Anthropocene was also obvious from the disgraceful amount of rubbish on the beach linked to BBQs!

Report and photographs by *Alan Holiday*

Orogenies Part 3: The Alpine Orogeny

The effects of the Alpine orogeny are seen in the rocks in the south and east of the U.K. in the strata of Triassic age or younger. As with earlier orogenic events already described in other newsletters, events started following the previous orogeny with the uplift and erosion, in this case of Middle and Late Palaeozoic rocks, to form sediments (sometimes termed molasse) of Permian and Triassic age as seen along the coast of south and east Devon from Paignton to Seaton. The effects of the Alpine Orogeny in the U.K. are confined to folding and faulting with no metamorphism or igneous activity. The Alpine Orogeny climaxed around 25-30 Ma ago with the closure of the Tethys Ocean between the African, European and Adriatic Plates creating the fold belt through S.E France/northern Italy/Switzerland/Austria. The Indian Plate also collided with the Eurasian plate to form the Himalayan mountain chain. This picture was complicated by the formation of the Pyrenees which is now thought to have had an impact on the south of England dated at between 118 Ma and 80 Ma Movement continued in the Pyrenean region through until about 25 Ma.

As we were well to the north (at least 600 km) of the main fold belt, the impact of the orogeny on U.K. rocks was limited. The pattern is also confused by earth movements during the Cretaceous (post-Wealden, pre-Greensand) which, for example, affected the Weymouth area and can be linked to the Pyrenean event and possibly to the opening of the Atlantic Ocean and the formation of the Bay of Biscay. The Weymouth Anticline, the Poxwell Pericline, the Ringstead Anticline and the Abbotsbury Fault were Cretaceous structures which were reactivated with Alpine movements. The effects of these events are perhaps more obvious in west Dorset and east Devon where the mid-Cretaceous unconformity is more apparent with Upper Greensand and Chalk resting on progressively older Jurassic and Triassic rocks with an overstepping relationship. The rocks of eastern England north of London are just tilted, dipping to the east or south east resulting from movements in the Pennines. Tectonic structures in the south of England are more interesting, however. The main Alpine structures, with an obvious E/W strike are seen in the Weald of Kent and Sussex as well as the Hampshire Basin and the London Basin.

There is also significant faulting with throws of up to 250 m. The faulting helped in the maturation of the oil-bearing strata that now forms the Wytch Farm Oil field in Dorset. A monoclinal fold in the Isle of Wight forms the central spine of the island.

Ballard Down Fault

Vertical strata, Durdle Cove

The northern limb of the monoclinal fold is steeper indicating pressure from the south. The effects were so severe that upending of the strata occurred, seen at the Needles and Alum Bay on the Isle of Wight. Vertical strata can be seen on the coast between Swanage and the Old Harry Rocks but the effects are very local as seen during a boat trip from Swanage. In the Isle of Purbeck, there are a series of folds offset from those of the Isle of Wight, possibly due to faulting.

The folds are 'en echelon' with steeper limbs to the north. The Lulworth coast shows the typical E/W trend of the folds and results in the longitudinal coast of the section from White Nothe to Peveril Point. Perhaps one of the best-known Alpine structures is the Lulworth 'Crumple' seen in Stair Hole, just to the west of Lulworth Cove. Dates for the development of these structures has been provided by improved techniques of U/Pb dating associated with calcite veins that cut


Lulworth Cove and Stair Hole


The Lulworth 'Crumple'

Jurassic and Cretaceous rocks in Dorset and the Isle of Wight. Dates between 55 and 25 Ma have been obtained. The Upper Jurassic, Purbeck Beds, have been intensely deformed into a complex anticlinal fold with some strata overturned. The Weymouth Anticline, like the folds, further east, also has a steeper northern limb with 10-20^0 dip with only 2^0 to the south on Portland. This has a significant effect on the topography with well-developed scarp and dip slopes both on the northern and southern limbs of the Weymouth Anticline as a north south traverse demonstrates from Portesham to Portland Bill. Thanks to Geoff Townson for advice on this item. Text and images by *Alan Holiday*

I really appreciate the articles from our regular contributors—there wouldn't be a Newsletter without them! That said, it would be wonderful to have some different authors chipping in. We have over 100 members who could perhaps be persuaded to write something, no matter how short, to provide some variety or even feedback and opinion on what is in print. I look forward to hearing from you. Thanks, ***Kelvin***

Field Trip Report: Lyme Regis - Pinhay Bay 4th July 2019. Leader: Geoff Townson

On a warm, calm, sunny day (for once), a dozen participants assembled by the Lyme Regis Boat Building Academy at 10.30 and Kelvin welcomed two new DGAG members. The party then moved to the display sign at the west end of Monmouth Beach where Geoff gave a brief overview of the global Triassic and Jurassic continental plate distributions, the location of the Central Atlantic Magmatic Province (CAMP) and NW Europe palaeogeographies.

Pinhay Bay: White Lias overlain by Blue Lias & Shales with Beef (WGT)

With a falling tide, the party then made its way across the Dorset/Devon border to Seven Rock Point. The view west from there shows the White Lias overlain by Blue Lias and the Shales with Beef. The White Lias is down-faulted below beach level at the western end of Pinhay Bay. The Chalk was visible at the top of the cliff amongst the wooded undercliff and tumbled blocks were visible on the beach in the distance.

The group then proceeded to the far end of Pinhay Bay where Geoff summarised the mass extinctions at the end of the Triassic and the uncertainty regarding the position of the Triassic/Jurassic boundary in the UK outcrops.

Some publications prefer to say that the boundary lies a few metres above the top of the White Lias (now the Langport Member of the Lilstock Formation of the Penarth Group), at the earliest appearance of the Hettangian zonal ammonite *Psiloceras planorbis* – assigning the "Pre-planorbis Beds" of the Blue Lias to the latest Triassic (Rhaetian).

However, recent publications have compared bivalve, coral, pollen and conodont extinctions with carbon isotope excursions and decalcification indicators and conclude that the Tr/J boundary could lie within the Cotham Member below the White Lias, or at the top of the White Lias (as traditionally and pragmatically placed). The End-Triassic Mass Extinction (ETME) is dated by some as 201.56Ma (+/- 0.6) and base-Jurassic as 201.3Ma (+/- 0.2).

The numerous CAMP igneous rocks (sills) in N & S America are all dated 201Ma (with various +/-, all <1). The massive injection of sills within Palaeozoic strata containing oil shales, carbonates and evaporites would have released sufficient carbon dioxide, methane and aerosols to produce a 5° C global warming and sufficient ocean acidification to cause extinction of many calcareous organisms (those corals, bivalves, ammonoids & nannofossils of the ETME).

Studying the White Lias at Pinhay Bay including a small fault with upward injection of calcilutite into grey shales (left). **(Images WGT)**

The group then studied small and large-scale features of the White Lias (deposited as lime mud, calcilutite): clasts with small bivalves, truncation surfaces, scour & fill, slumping, firm-grounds, hard-grounds, burrows & borings, diapiric soft sediment injection, firm-sediment conglomerates, and synsedimentary listric faulting. These shallow-water carbonate sediments have been described as "seismites", implying that slumping was caused by earthquake &/or meteor impact shockwaves.

The overlying sediments are dark laminated organic shales through which some injection of white calcilutite had taken place. During a picnic lunch at Seven Rock Point Geoff demonstrated the organic carbon content of these basal shales by qualitative field pyrolysis - attendees were quick to recognise the smell of the volatiles driven off and the brown colour of the distillates on the Pyrex tube. The Blue Lias cycles of shale>marl>limestone were discussed. Essentially, these are repetitive variations of calcium carbonate (biogenic) and clay (terrigenous), reflecting changes in environment, possibly every 50-100,000 years. These could be caused by minor increases in sea level decreasing clay input, or repeated changes in climate causing variation in the population of calcareous organisms – or both.

Geoff demonstrating the organic carbon content of the basal shales by qualitative field pyrolysis (KJH)

There is not enough resolution to invoke Milankovitch cycles but there may be some form of "orbital forcing" involved. Basically these are repetitions of oxic vs anoxic seabed conditions in a broad continental shelf sea. Similar conditions prevailed during deposition of the Belemnite Marls of the overlying Charmouth Mudstone Formation but, due to less burial, diagenesis did not result in such hard limestones as in the Blue Lias.

The party slowly climbed the succession eastwards, ledge by ledge, noting the abundant trace fossils, ammonites, crinoids, bivalves, brachiopods, gastropods, nautiloids, wood and possibly bone.

There were also many thoroughly bioturbated Upper Greensand blocks of chert and sandstone with the serpulid *Rotularia*. A linear "pressure release" anticline was noted, as were remains of a narrow gauge railway track and cableway link to The Cobb. The Blue Lias limestones were quarried from the beach for lime burning and the Upper Greensand "Cowstone" concretions were used in the construction of the early forms of The Cobb.

Chippel Bay - Linear anticline in Blue Lias (WGT)

Some of the group then walked on The Cobb, noting the Upper Jurassic Portlandian bivalves, ammonites, gastropods and calcareous algae visible (but worn) in the cladding of the outer seawall. Geoff compared the gastropod moulds (*Aptyxiella*) with a modern example he happened to have in his pocket. (This fossil assemblage is unique to the Freestone Member of the Portland Limestone Formation of the northern part of the Isle of Portland. Geoff also pointed out Upper Greensand cowstones are still visible in places.

Following a vote of thanks, the party dispersed but some members walked east (with ice creams) to view the beach stabilisation measures, Carboniferous Limestone corals (bridge parapets), grey Portuguese granite, Portland and Purbeck building stones, weathered Blue Lias, Upper Greensand Chert (most likely from Hardown Hill) and the view of the Black Ven landslip complex. Beyond, clearly visible, was the Cretaceous Upper Greensand on Stonebarrow and Golden Cap, then Thorncombe Beacon, West Bay, Burton Bradstock and Chesil Beach to Portland on the horizon – a grand day out…*Geoff Townson*

***Aptyxiella* moulds in the Portland Roach (WGT)**

A Song of Geology

I'll sing you a song that needs no apology-

Attend, and keep watch in the gates of your ears!-

Of the famous new science which men call geology

And gods call the story of millions of years.

The minim of being, the dot of creation,

The germ of sire Adam, of you and of me,

In the folds of the gneiss in Laurentian station,

Far west from the roots of Cape Wrath you may see

Minims of beings, budding and bursting,

All on the floor of the measureless sea!

Small, but for mighty development thirsting,

With throbs of the future, like you, sir, and me!

Extracts from a poem by John Stuart Blackie. Contributed by Alison Neil

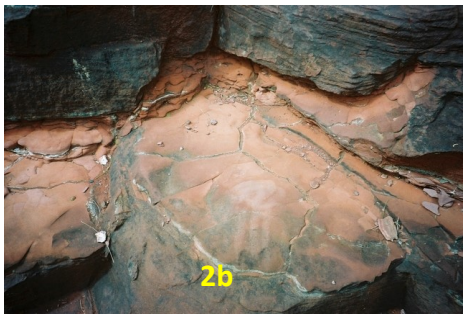
If anyone else has short extracts like this please let me know. *Kelvin*

Moroccan landscapes and examples from the past

On my recent visit to Morocco not only were the fossils very exciting but I was also impressed with the variety of landscape features. Morocco is in north Africa bordering on the Mediterranean in the north, the Atlantic Ocean to the west and Algeria to the east. Our visit took us from Marrakesh across the Atlas Mountains to the south east of the country on the northern edge of the Sahara Desert. As we drove south and east, the country became more arid although as we visited in April there is some rainfall and some of the river channels had water in them.

While visiting the fossil rich localities I saw landscape features that reminded me of the geology of south Devon between Brixham and Budleigh Salterton. In Morocco, there are extensive areas of sand dunes (picture 1a) often crescent shaped barchan type dunes. The picture shows part of the El Chebbi dune field near Erfoud. Along the Devon coast north of Dawlish, Permian sandstone can be seen with large scale cross bedding formed as the dunes migrated around 280 million years ago (picture 1b). This type of comparison helps with the basic tenet of geology, 'The Present is the Key to the Past' or Uniformitarianism.

Another feature seen in Morocco, during a lunch stop at an oasis, was some mud cracks. It does rain periodically, and rainfall can be quite intense. The water can collect in depressions between the dunes carrying fine clay sediment. As the water evaporates mud cracks can form (picture 2a).



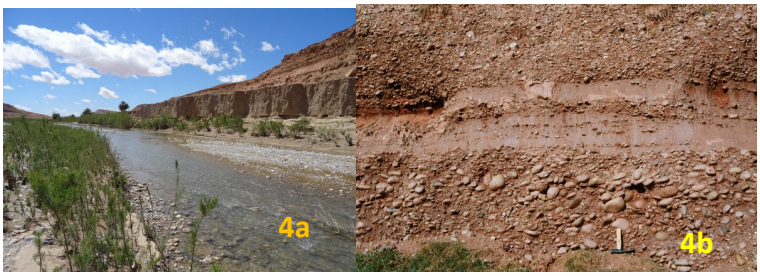
On the coast just south of Paignton Harbour good examples of desiccation cracks can be seen in the Permian sediments (picture 2b).

In desert areas when it rains, flash floods can occur, especially in narrow valleys as in the gorge in picture 3a between Ouarzazate and Alnif. As there is little vegetation, the water runs off the slopes into the valleys carrying lots of coarse sediment with pebbles, cobbles and even boulders. Alluvial fans can be formed. Picture 3b shows the type of sediment that can be transported by the flash flood events. These are similar deposits of Permian age south of Paignton (Waterside Cove). Here, flash flood sediment (Permian) rests unconformably on Devonian rocks (380 Ma.).

Sometimes rivers flow for longer periods and better sorting occurs as seen in picture 4a) p.10. At Budleigh Salterton, the Budleigh Salterton Pebble Beds show similar sediment but of late Permian or early Triassic age (picture 4b), p10.

Another feature commonly seen in Morocco were rocks coated with iron oxide known as desert varnish (picture 5a, p.10) and at Budleigh Salterton there is a horizon with hematite coated pebbles (picture 5b, p.10).

Permian and Triassic sediments outcrop widely in the UK, not just in south Devon for example in the Midlands around Kidderminster and Bridgnorth. You may live near some of these distinctive orange red rocks or see them when travelling. They tell of you of a time when the UK was part of the Pangea Supercontinent and we were along way from the nearest sea rather like southern Morocco. *Alan Holiday*



4a) Contemporary river channel

4b) Budleigh Salterton Pebble Bed river channel deposits

5a) Modern desert varnish, Morocco

5b Hematite coated pebble close-up

We plan to feature Morocco at this year's Holiday Rocks event in October. The talks will feature landscape features, sedimentary structures and paleontology as the latter was the primary aim of the tour. There will also be a few specimens at hand, including trilobites of course! *Kelvin*

The Hot Rock Slot

Carbonatites

Dorset is particularly well endowed with carbonate rocks in the form of limestones which are, of course, of sedimentary origin. However, it may come as a surprise to learn that carbonate rocks of igneous origin also exist (though not in Dorset!). Known as carbonatites, carbonate-rich igneous rocks are relatively rare and occur in a very distinctive geological setting, but their origins are still somewhat controversial.

Carbonatites may be subdivided on the basis of the dominant carbonate. Calcite-rich types (sövites Fig.1) are the commonest but dolomite and ankerite-rich varieties do occur, also a rare type dominated by sodium and potassium carbonate minerals (natrocarbonatites). Many carbonatites contain some non-carbonate minerals, usually in minor amounts. These include silicates (e.g. olivine, aegirine-augite, phlogopite Fig.2), phosphates (e.g. apatite and monazite: cerium phosphate) and characteristically: magnetite, perovskite, and pyrochlore: calcium niobate. But for this exotic mineralogy, they are easily mistaken for marbles. In the eroded remains of the former volcanoes at Bukusu, Napak and Totor in Uganda and Kisingiri in W Kenya, also Chilwa in Malawi, carbonatites are associated with nepheline-rich alkaline ultrabasic rocks such as nephelinites and ijolites. Here the carbonatites form central intrusive plugs often surrounded by an intrusion of ijolite and with overlying volcanic rocks above that are composed mainly of nephelinite tuffs and lavas.

Fig.1. Hand specimen of a carbonatite (olivine sövite) from Jacupiranga, Brazil. Image: https://en.wikipedia.org/wiki/Carbonatite.

Around the intrusive rocks, the basement granitic gneisses are invariably and extensively contact-metamorphosed, shattered and 'fenitised'.

Fenitisation is a type of metasomatism (i.e. modification of bulk-rock composition by the action of percolating fluids) involving wholescale addition of sodium and potassium.

Fig.2. Photomicrograph of a carbonatite (phlogopite sövite) from Oka, Quebec. Note greenish-brown phlogopite, opaque magnetite and abundant twinned calcite. Long axis of field of view = 2mm. Image: Giles Droop.

Some granites recrystallize as riebeckite nepheline 'syenites'. This is a characteristic feature of carbonatite-ijolite complexes.

Although most documented carbonatite occurrences are intrusive, extrusive examples are known. The most famous of these is the active volcano Oldoinyo Lengai in N. Tanzania (Figs.3 & 4) which is built of carbonatite and nephelinite lavas and tuffs. It has erupted natrocarbonatite lavas several times within the last few decades. These lavas have very low viscosities and typically form ropy pahoehoe flows. They are erupted at relatively low temperatures (~500ºC, so are only weakly incandescent) and are black when they solidify, but quickly weather to white material (Fig.4).

Fig.3. The volcano Oldoinyo Lengai in Tanzania, during its 2008 eruption. Image: Dr Sarah Stamps, Virginia Tech. https://vtnews.vt.edu/articles/2016/06/science-volvcanotanzaniastudy.html

Fig.4. Natrocarbonatite cones in the crater of Oldoinyo Lengai. Image: Michael Le Bas.

The greatest development of carbonatite-nephelinite magmatism is in continental rift zones. Of these, the most spectacular and extensive is the East African Rift, but other examples include the Rhine and Oslo grabens in Europe and the Ottawa Graben in Canada, with the most famous carbonatites occurring at Alnö in Sweden, Fen in Norway and Kaiserstuhl in Germany. The only British carbonatite is associated with the Caledonian Loch Borolan alkaline intrusive complex in the Assynt district of NW Scotland and is a small outcrop of sövite on the shore of Loch Urigill.

Measurements of strontium, lead and neodymium isotopic ratios leave no doubt that carbonatite and nephelinite magmas originate in the mantle (probably at great depth), but the origin of the former is still a matter of debate. Three mechanisms have been proposed: (i) as the initial product of partial melting of carbonate-bearing mantle rocks; (ii) as the final product of the differentiation of a silicate melt containing dissolved carbonate; (iii) by liquid immiscibility from an initially homogeneous carbonate-bearing silicate melt. Of these, the third has gained most traction in recent years, supported as it is by unequivocal experimental and petrographic evidence.

In some carbonatite bodies, rare minerals are sufficiently abundant to form economic mineral deposits. Around the world, carbonatites are mined for phosphorus, rare-earth elements (REE), zirconium, niobium, tantalum, uranium, thorium, copper, iron, vanadium, titanium, barium and fluorine. Most of the global REE production and reserves are in carbonatites, notably the Bayan Obo deposit in China and the Sulphide Queen carbonatite in California.

Giles Droop and Michael Le Bas

Book review: “Trilobites, Dinosaurs and Mammoths” by James McKay.

Pub: The Palaeontological Association @ £7.

This slim volume is sub-titled ‘an introduction to the prehistory of the British Isles’ and in just 45 pages covers the evolution of life through time. It contains small palaeogeographic maps and accompanying explanatory text for each topic covered, from the Archean to the Holocene. I really like the palaeoart which accompanies each topic or Formation. If you want a quick guide to the rocks and fossils of the British Isles, this is it. *Kelvin Huff*

Kingston Lacy Part 5: Interior Stone - Sedimentary

William Bankes transformed the Kingston Lacy interior into an Italian palazzo with many floors, walls, columns, sculptures, fittings and collector's items of both local and European stone imported via Venice under his personal supervision.

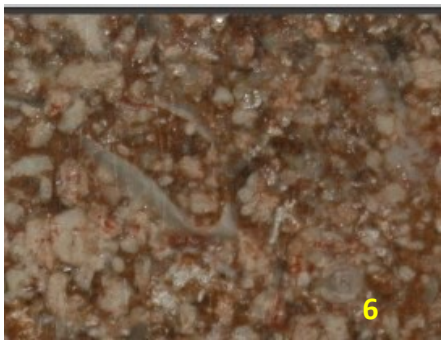
The painted entrance hall columns(1) and walling are supposedly Portland Limestone, a freestone but Charles Barry was positioned to make a two third's cost saving had he chosen to use again but at Kingston, the William Ranger's patent artificial Portland Stone replication (Part 1. Image 18.) The sculpted coat of arms tympanum is oolitic Wardour Upper Building.

The 25 inscribed tombstones, stelae of the Egyptian Collection, are made from the extracted tunneling waste removed from the Valley of The Kings burial chambers. It is a chalky white, Eocene Limestone from the central member of the local Serai Formation (ref: Judith M. Bunbury "Geology of the Valley of the Kings"). This is a fine-grained freestone ideal to take the paint and gold leaf for tombs of the Pharaohs and also a freely available building and stelae stone of the Deir el Medina tomb-masons to the Pharaohs. See Google link

The striding figure below (3, 3a), recovered from the House garden, has the features of Rameses II. According to the Kingston Lacy guide book and their room notes it is a greywacke of unknown provenance and dated at 123 BC. Bekhen Stone, a Precambrian metagreywacke sandstone, was quarried for sculpting in the Wadi Hammamet Pass, the main Eastern Desert route-way east of Luxor, from pre-historic to Roman times. (Ref. Evaluating the Cultural Heritage and landscape of Quseir - Qift Road: with a special focus on the gold mines and greywacke quarries. 31 Jan. 2017 Univ. Padua, Archaeology Dept.). Fatima Al Fihri Project.
http://paduaresearch.cab.unipd.it/10241/1/Tesi_Elsayed_Ahmed.compressed.pdf

Polished Limestone - intensely altered, veined, deformed and variously coloured deeply buried sediments. All the additional interior sedimentary stone has been deeply buried or compressed. Well known since Roman times, sedimentary evaporites and hard limestones can also be made to take a polish, and to compete commercially with true, metamorphic marbles.

Imposing crinoidal bioclastic limestone (4), probably European not British, was used by William Bankes for the communal faucet bowl, National Trust buffet, set amongst bedrooms and which pre-dated the first proper flushing water closet in Kingston House. Star-shaped crinoid ossicles (*Pentacrinus*), mussel shell and minute gastropods can be seen with a hand lens.



Bioclastic crinoidal limestone detritus at low and high hand lens magnification (5.6)

Black chequerboard flooring from Hainault or Tournai, were well-stocked by 19th century Italian suppliers (7). Together with white or graphite disseminated Carrara Marble, the high status Royal and later major western city halls, were floored with uniform, chequerboard slabs.

Bankes perhaps economised by minimising the slab size of the always dangerously and expensively mined Belgian Black limestone. His effect is perhaps even more tasteful.

8.Belgian Red Limestone and 9. French Red Languedoc - Top landing.

He also economised by using Belgian Red Limestone, (rather than high status French Red Languedoc) for the fireplace in the National Trust Office.

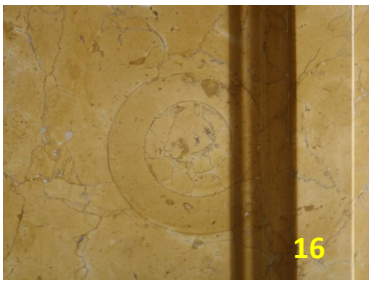
Alabaster

Geothite dissemination of oxidised iron, gives the red/browns and less oxidised blue/greys to the staircase balusters of typically cloudy and banded English alabaster/gypsum – almost certainly ordered by Charles Barry from a Derbyshire source.(10) Differently cloudy dissemination here (11,12), enhanced in active ornamental electric light fittings. Installation (date unknown).

Transparent alabaster was used just for light access in some historic Italian buildings. At Kingston Lacy, another 19th century Italian idea had mirrors set to reflect light deep into the house on two separate upstairs floors. (13.14)

Verona Red Ammonite Formation

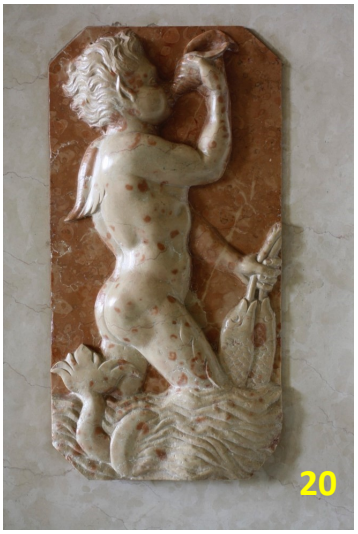
Most polished stone at Kingston House is the Verona limestone, from the Valpolicella Region at the foot of the Alps of the Verona Red Ammonite Formation. (Oxfordian, Upper Jurassic 285 Ma.) It is an hematitic, stylotised, commonly nodular succession of condensed sediments on an ancient submarine plateau. The commercial marbles, polished limestone red-Rosso, pink-Nembro rosato, yellow Giallo, and white Bassano Biancone, are all well represented at Kingston Lacy. The yellow Giallo texture is very commonly nodular and often with occasional macro fossil inclusions. Here is the location of a 1" wide and sectioned, *Rhynchonella*, in the left-hand side Drawing room/ Dining room entranceway.



The *Rhynchonella*, seen here centrally with calcite mineral veining and alteration weakness fracturing to the right. (15)

A nice sectioned ammonite(16), one of many in the Drawing Room fireplace and together with the sculpted vase on the mantelpiece(17), revealing considerable stylolite weakness.

Stained orange/red by a blending of iron oxide/geothite and hematite, this is the dark, polished Rosso di Verona. This world famous nodular limestone reaches the surface near Lake Garda. The paws are of Bianco di Verona. (18)



Smaller nodules in pink Nembro Rosato (19,20) with an adjacent white bedding layer, are from the higher, Upper Jurassic deposits. The red spotted staining is accounted for by oxidised worm holes and geothite-filled cavities in the white Bianco di Verona beds below the Nembro Rosato.

Sadly with no scale (21), here are the very small nodules in the Nembro Rosatto as compared with the very large nodules of the Rosso di Verona. As seen in the garden's two 1848 scaled-down replicas of the lions at the foot of the Capitol in Rome.

Good stylolite texture, in the white micritic Bassano Biancone stone stair-rails and adjacent walling.(22)

This article concludes overleaf. The Winter Newsletter will feature the next in the series on Kingston Lacy plus an update and answers to the garden features covered in part 3. KJH

Microbial mats were laid down in the Tethys Ocean, preceding the Mediterranean Sea. They were important in trapping and binding the Verona Limestone Formation sediment, giving rise to early lithified nodules and stromatolitic layers. From the Upper Bajocian to the Upper Oxfordian pseudo nodular textures turned to massive bioclastic facies with much fossil content and finally these sediments were characterised by a long period of true nodular facies. The burial and tectonic compression of subsequent Alpine and Apennine orogenies removed vast volumes of material by pressure dissolution and thus stylolites are so much in evidence amongst all Kingston Lacy's polished Verona Limestone. *All text and images by Peter Bath*

DGAG Dinner Saturday November 16th 2019

For this year's dinner we are going to the Rembrandt Hotel in Weymouth. The Wessex Hotel are now employing outside caterers and have increased their prices considerably so we are heading south of the Ridgeway! We have our own function room (the Aylesbury Suite) and a three-course meal as before - but with a few differences.

The starter will be soup or fruit juice served at the table followed by a serve-yourself carvery. You are allowed to go back for seconds apparently! There will be a vegetarian option and the hotel can cater for any special dietary needs. The main course is followed by a choice of desserts served at the table. Tea and coffee can be ordered at the bar.

This year's guest speaker is Dr. Jon Murden of Dorset County Museum, who will no doubt fill us in on the exciting new DCM, due to re-open in the summer of 2020.

The cost of the evening is £25 per head payable in advance to Alison, our Treasurer. I suggest we all meet in the bar at 7.00 for a 7.30 start. If you would like to come along please complete and return the slip enclosed with this Newsletter, together with the appropriate amount, to Alison. The Rembrandt Hotel has ample parking both front and rear. It is on the Dorchester to Weymouth bus route and the train station is a 15 minute walk.

I do hope you will be able to join us. (Before anyone asks I don't know the choice of desserts or the flavour of the soup, but we'll find out on the night!) *Kelvin*

DGAG Residential weekend 2020

We have been running these successful trips for several years now. We've been to Shropshire (twice), Cornwall (twice), the Forest of Dean and south Wales. I may have forgotten to mention others! In 2018, we called in for a day in the Black Country on our way back from Shropshire and were shown around the Wren's Nest and Saltwells by Graham Worton, the Black Country Geopark supremo. DGAG member Noel Donnelly was so impressed he has offered to lead another trip to the Black Country for us next year. Details and joining instructions will follow in due course - I do hope you can join us.

Perhaps you have knowledge of a particular area you can share with us? We are always looking for suggestions (and leaders!) for field-trips so please let any committee member know if you can help. *Kelvin*

Future events reminder

We have our **Holiday Rocks** event on Saturday **26th October.** Please let me know if you could speak for a few minutes (or more!) on 'geology from my holiday'. Also any items you wish to donate for sale at our **Xmas Workshop** on **14th December** would be gratefully received by me. *Kelvin*

DGAG Field Trips and allied events 2019 - 20

To book a place on our field-trips, contact Kelvin Huff or Alan Holiday using the details below. £2.00 day trip fee.

September 1st: Exmouth and Budleigh Salterton. Leader: Geoff Townson

Saturday September 7th: Hampshire Mineral and Fossil Fair, Lyndhurst. 10 a.m. - 4.00 p.m.

Sunday September 8th –talk at The Etches Collection, "Ammonites to Octopods". 2.30 p.m.

Wednesday September 11th: Lecture: Brooke Johnson (University of Oxford) "Ferruginous upwelling and phosphate availability in the Roper Basin, Australia".

Wednesday October 9th: Lecture: Dr Sarah Boulton (University of Plymouth) "When did the Moroccan High Atlas get high?"

Saturday October 26th: Holiday Rocks. Broadmayne Village Hall. 2 p.m.-5 p.m.

Wednesday 13th November: Lecture: Dr Stewart Ullyott (University of Brighton, Rtd.) "Sarsens: Troublesome Stones of Dubious Origin".

Saturday November 16th: DGAG Annual Dinner at the Rembrandt Hotel, Weymouth. Guest Speaker: Dr. Jon Murden of Dorset County Museum. 7.00 p.m.

Saturday December 14th: Xmas workshop at Broadmayne Village Hall, 10 a.m. – 4 p.m.

Saturday January 11th: DGAG AGM, Broadmayne Village Hall. 2 p.m.-5 p.m.

Website: https://dorsetgeologistsassociation.org/

DIGS (Dorset's Important Geological Sites)

The group welcome 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.

Sunday, 29th September: Geology and Fossils, Lyme Regis with Sam Scriven

Sunday, 6th October 2019: Raised Beaches of West Sussex with David Bone

Sunday 20th October 2019 : DIGS/OUGS conservation session at an LGS.

Sunday 10th November 2019: Introduction to Geology, Bowleaze Cove, Weymouth, Dorset, Alan Holiday.

Saturday 25th January 2020 : Wessex Branch AGM and Day of Lectures, Wool, Dorset

Reminders: Contributors' deadline for the Winter Newsletter is: **Monday 25th November**

Committee news:

We **still** need an Events and a Fieldtrip Officer!

Kelvin

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