Dorset GA Group

Newsletter Summer 2019

https://dorsetgeologistsassociation.org/

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Insert: Kingston Lacy Part 3.

Welcome to the Summer Newsletter!

In this issue Pete Bath's Kingston Lacy series continues with Parts 3 and 4 . We have had a very successful weekend in South Wales as well as several day-trips. The excellent lecture series organised by Jeremy continues to attract good-sized audiences of well over 40 people. The Committee is working hard to provide a varied programme for you, and Geoff Rowland has worked wonders with our website. Do please sign up for our events, you will be made very welcome.

Have a good summer! *Kelvin*

DGAG at Bran Point...

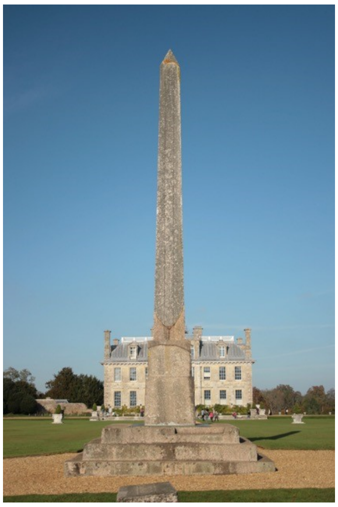
...and at Dunraven Bay, Glamorgan

Kingston Lacy Part Four: Garden Stone

The south lawn garden stone is a Grand Tour Collection illustrative of prestigious historic monuments and ornamental garden pieces sculpted for display in Mediterranean climates; so subsequent weathering here in Dorset, is perhaps the most distinctive feature for visitors today. To minimise further damage from frost the Trust keep the entire collection of garden sculptures boxed in for up to five months in the Winter. Fortunately, all the garden stone but for the Istrian limestone, is available to view close up, clean and polished inside the House, (and that begins in Part 5.) Meanwhile see Easter Appendix 2019 on page 3, whereby true colouring of the 'Rosso Verona' garden features can now be compared. ***All photos are by kind permission of the National Trust.***

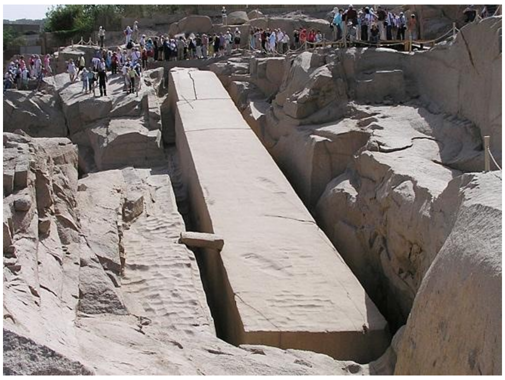
Rosso Veronese Stone plinths below bronze lions, guard the lower stairway. A pair of tall Verona Stone urns on bronze tortoises and many lichen-coated Carrara marble urns border the gravel drive. The stairway to the lawn, between stone mounted bronze lions, separates more Carrara vases and Verona Stone well heads. The much weathered Rosso Veronese lions now reveal exaggerated stylolites, algal texture decay and the colouring is masked by today's organic cover. In their home climate they would still display an evident structural solidity as is well seen represented by features inside the House.

The very organically coated tortoise mounted vases and plinths to the garden staircase are also of a Rosso Verona marble.
The matching pair of well heads on the lawn; one a much weathered clean limestone, are of 'Istrian marble' and were originally a pure white, highly polished limestone as translucent as Apuan white marble. However, spalling of this polished facing at Kingston has almost entirely been weathered away, leaving a rather coarse limestone finish to the elaborately carved faces and emblems. (See the middle close-up photo for remaining marbled white finish.) This stone was incidentally the main building stone of Venice and sourced from almost directly across the Adriatic from Eastern Europe.



There are 29 known Aswan granite obelisks remaining and this Google images photo illustrates the risks involved in extraction of such great weights.
William Bankes imported and re-erected one of two abandoned Aswan statuary granite obelisks found abandoned on the Isle of Phlae. He had the best one jointed with part of the second and set all above a matching stepped plinth retrieved from further down the Nile.

Gifted to William Bankes in 1822, the complete Statuary Aswan Granite Sarcophagus is 8ft long and note the plinth, below head, was originally brightly polished and heavily engraved with hieroglyphics. (Note the reverse Lewis lamp holes in the lid.)



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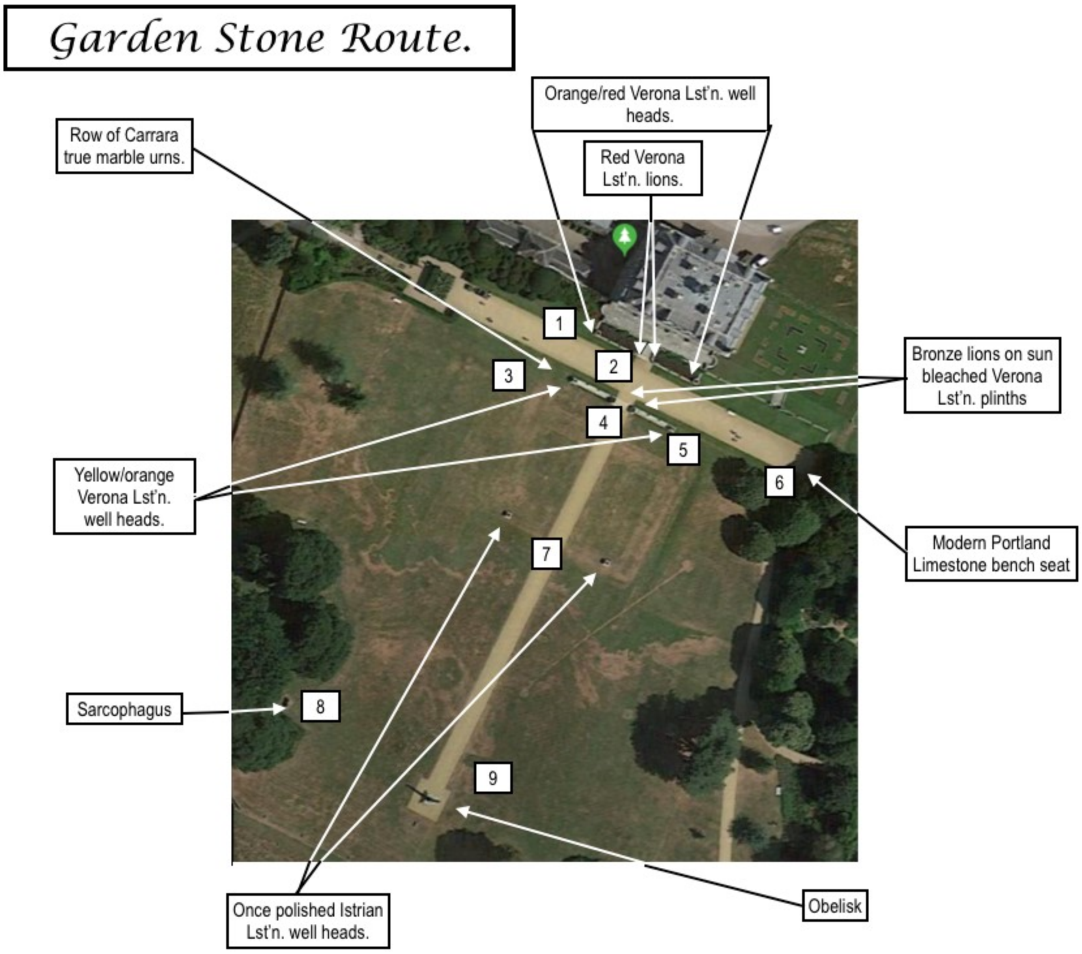
Statuary red Aswan Granite is coarse grained with + - 3-5 cm iron rich - so pink to red - orthoclase feldspars akin to U.K. Shap granite.

This article continues on page 3. Please note that Kingston Lacy Part 3 appears as a separate insert in this issue so it can be used 'in the field'.

The garden terrace and House south wall stone has considerable lichen coverage and is fenced off in winter.

However, using a good hand lens, and better still using an LED loupe, the texture of Portland Freestone can be revealed. More Portland Freestone has been added between the House and the present National Trust shop. (See images below)

Good frost-free weather allowed another visit to the Garden Stone at Easter 2019 to better reveal the true effect of exposure to weathering that the wooden frost protection covers are intended to reduce.



Clearly the nodular and stylolitic texture, of most Italian-sourced stone features, is very much at frost damage risk. Again, the possible affect of acid rain on the once very sharply-cut hieroglyphics of the Aswan Granites, may need N.T. consideration. However, the effect of organics; lichens etc. and even sunlight on the coloured limestones, seriously obliges visitors to explore their interior use by William Bankes in his ‘marble-rich’ Italianate palazzo - Kingston Lacy House.

Verona Limestone was readily available to William Bankes living in Venice and he personally supervised loading and shipping his stone. Oxidisation of iron in this stone provided a range of colours from cloudy yellow to orange and popular strong reds - the 'Rosso Verona marble’.

Western and Eastern pairs of features Nos 1/ 2/ 4/ & 5 - as above and including the images below, show how far the texture and colour may have been hidden by exposure. On site, the outline of nodular algal texture and the zig-zag cracks of stylolites - very fine pressure-dissolution cracks - can help with identification. In some Verona Limestone garden features, all colour has gone. (notably in 3 & 5 below.)

Text and Images by *Peter Bath*

Report: Field Trip to Purbeck 23/3/19.

a.m. A group of 17 assembled at Lander’s Quarry on a chilly, overcast day to meet our host for the morning, Trev Haysom. We began by inspecting some of the specimens in the yard, found during the course of quarrying the Purbeck Limestones over the years. These included dinosaur footprints made between 139 and 145 million years ago and infilled by lime rich muds when in Purbeck times, the area was a series of shallow, brackish-freshwater lagoons. The footprints included those made by sauropod (large and saucer-shaped) and tridactyl dinosaurs (three-toed, bi-pedal).

Report continues on page 5.

We also saw tree material, gypsum and desiccation cracks, all characteristic of the lower Cretaceous Purbeck lagoons, as well as the *Titanites* ammonite, diagnostic of marine incursions. We were then shown around a large storage shed, packed with more specimens and material relating to the medieval phase of quarrying. Trev spent some time explaining the techniques employed by the medieval quarrymen and masons, a fascinating collection. To give us more insight into this era, we then descended a medieval drift mine which has been partially opened up to reveal more secrets about the techniques and mining conditions of this period. Dark, laborious, muddy and cramped would be a fair summary! At almost the furthest point we were amazed to see a partial dinosaur trackway on the mine roof. We re-traced our steps to emerge at the surface to discover a shark fin spine had been discovered by a quarry worker that morning (probably a hybodont species). Trev was warmly thanked for showing us around before we made our way to the Square and Compasses for lunch. *Kelvin Huff*

Going underground... (PJB)

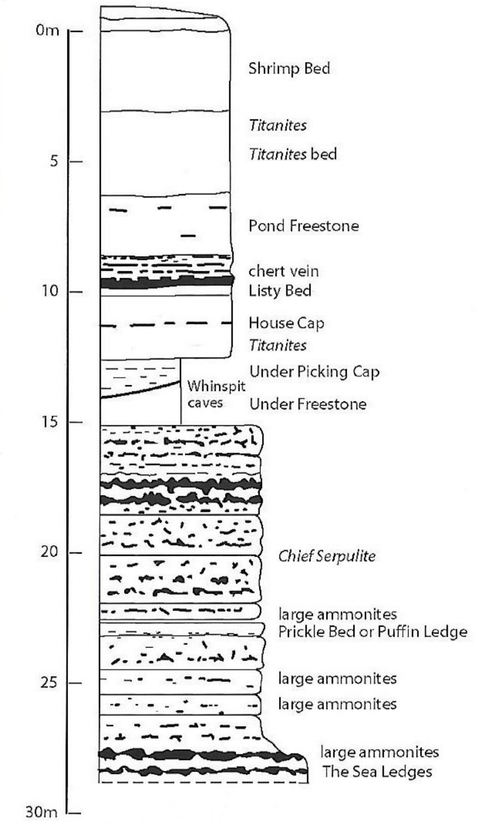
Tridactyl dinosaur footprint (KJH)

Inside Trev's 'Museum' (KJH)

p.m. Following lunch at the Square and Compass we followed the footpath from Worth Matravers to Winspit and then on to Seacombe, later returning to Worth Matravers. Worth Matravers is a nucleated village very different to Langton Matravers which is much more linear. John Chaffey in his book Purbeck Landscapes suggests the name 'worth' refers to the enclosure of farmland and suggests a Saxon origin. The services in the village have declined over the years and now there is the Square and Compass pub, a tea shop and the church which is entirely Medieval (early 12th C.) (which John Chaffey said in his book is unusual). The exterior has a corbel gable with carved animal and human heads as seen in the picture to the left. There have been additions to the church in the 18th and 19th C.

The old school, now the village hall, opened in 1850 and closed in 1922. London Row which leads to Winspit is a row of 19th C quarrymen's cottages. Leaving the village along London Row we followed a quite deeply incised valley with a small stream which may flow in the winter after heavier rainfall. However back in Pleistocene times, with melt water and permafrost during the glacial episodes, there would have been a much bigger stream which helps to explain the deep valley. In summer the water table would be below the surface and this would be a dry valley. As we approached Winspit we saw the strip lynchets on the side of East Man and West Man, evidence of Medieval or earlier farming activity. We saw similarly deeply incised valleys on leaving the coast at Seacombe and made our way back to Worth and again seeing strip Lynchets.

On the next page is a diagram representing the Portland Bed sequence in Purbeck as seen at Winspit. These rocks are slightly older than those seen in the quarry visit being 147.6 to 144.8 Ma compared with the Purbeck Beds 144.8-138.8 Ma). The name Winspit is apparently derived from 'a stone pit with a winch'! This is the oldest of the quarry complexes on the south coast of Purbeck and access is provided to reach the cliffs by the deeply incised valley already mentioned. The sequence in Purbeck is around 32 m. thick, somewhat thicker than on Portland (17 m.)



Two beds of stone were exploited, the Under Freestone (caves) and the higher Pond Freestone on the valley sides. The Cherty Beds form the lower sea cliffs and there are excavations at sea level where barges could be loaded with stone to be taken to Swanage for forward transport as seen in the picture below.

Quarrying took place from around 1700 and ceased after WWII. Chert does occur in the higher beds, but it is much less common. See picture below of a flattened nodule as it was easier to spread laterally than vertically. Although the picture may look like a section through an ammonite, I think this is a chance happening and not organic. The beds are not particularly fossiliferous except the Prickle Bed or Puffin Ledge (this equates to the Basal Shell Bed on Portland).

Walking on along the coast path we reached Seacombe where the Under Freestone was exploited until the 1930s. The Pond Freestone was not well developed and not exploited here. The caves cut by quarrymen are now bat roosts. The term freestone is one that describes a stone, a sedimentary rock normally poorly-jointed (limestone or sandstone) that can be cut in any direction. Report and photographs by *Alan Holiday*

THE HOT ROCK SLOT

GRANULITES

The term ‘granulite’ is short-hand for ‘granulite-facies metamorphic rock’, i.e. a rock belonging to the highest-temperature facies of regional metamorphism. The boundary between the amphibolite facies and granulite facies is usually defined by the appearance of the mineral ortho-pyroxene in rocks of basic composition.

Granulites are characteristic of the broad areas of high-grade regional metamorphic rocks exposed in Precambrian shield areas (e.g. Fennoscandian Shield, S. India, Canadian Shield, Brazilian Shield, East Antarctic Shield etc).

However, although many granulite-facies terranes are Precambrian, some are known to be Phanerozoic. Much of the present-day lower continental crust is thought to consist of granulites.

The tectonic settings proposed for granulite-facies regional metamorphism include (i) deep levels in island arcs/Andean orogens; (ii) back-arc basin settings; (iii) deep levels in collisional orogens. Granulites can also develop in contact-metamorphic settings, i.e. in the inner aureoles of deep-seated basic or ultrabasic plutons.

Temperatures recorded by granulites range from *ca*. 750°C (the top of the amphibolite facies) to *ca*. 1050°C. Some rock types, for example pelites (metamorphosed mudstones), are partially molten at these temperatures. Pressures spanned by the granulite facies range from ca. 4kbar (the upper boundary of the pyroxene-hornfels facies) to ca. 16kbar (the lower boundary of the eclogite facies). 4kbar corresponds to a depth of ~14km, 16kbar to ~56km.

Granulite mineral assemblages are dominated by anhydrous minerals (e.g. garnet, pyroxenes, olivine, feldspars, quartz, sillimanite, kyanite, cordierite, spinel, corundum, in various combinations, depending on rock composition). The rare minerals sapphirine (Fig.1) and osumilite are virtually restricted to granulites and are indicative of extreme temperatures. The hydrous minerals hornblende and biotite persist into the granulite facies (though tend to be volumetrically minor and with unusually F-rich and Ti-rich compositions), but muscovite, chlorite and epidote are not stable at all at such high temperatures. Carbonates (calcite, dolomite, scapolite) persist in marbles (metamorphosed limestones) of suitable composition.

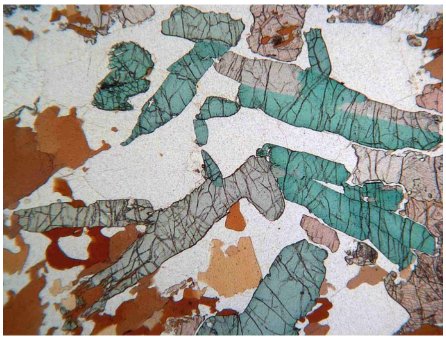


Fig.1 Photomicrograph of sapphirine granulite from Val Codera, Central Alps, showing sapphirine (blue), biotite (brown) orthopyroxene (pink) and cordierite.
Long axis of field of view = 5mm.

Fig.2 10cm-diameter garnet crystal within garnet pyroxene plagioclase gneiss in the Ivrea Zone, N. Italy.

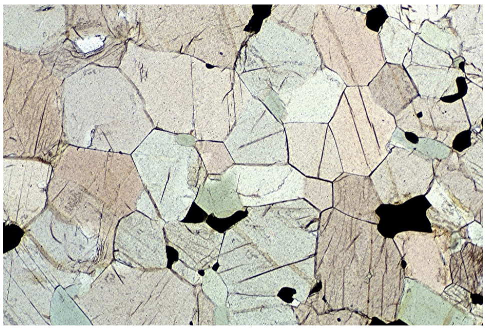


Fig.3 Photomicrograph of a meta-pyroxenite from Scourie, NW Scotland, showing the 'soap-bubble' texture characteristic of many granulites. The minerals are orthopyroxene (pinks), augite (very pale greens), hornblende (olive greens) and magnetite (opaque). Plane-polarised light. Long axis of field of view = 5mm.

Texturally, most granulites are medium-to coarse-grained (Fig. 2), and may be described either as granofelses (lacking foliation or lineation) or gneisses (possessing foliation or lineation). Mineral grains within granofelses commonly have polygonal 'soap-bubble' shapes indicating a close approach to textural equilibrium (Fig. 3). Pelitic granulites are commonly migmatitic, i.e. contain distinct quartzo-feldspathic segregations (leucosomes) that represent granitic melt that formed by in-situ partial melting when the rocks were at high temperature (Figs. 4 & 5). Extraction of melts produces refractory rocks (restites) that are poor in quartz and feldspar and correspondingly rich in Mg, Fe, Al-rich minerals (Fig. 6). *[see page 8]*

The largest outcrop of granulites in the British Isles is the Scourian part of the Lewisian Gneiss Complex of NW Scotland, and is best seen in coastal exposures in the vicinity of Badcall and Scourie in what used to be called Sutherland. The rocks are of Archaean age and consist mainly of grey two-pyroxene quartz feldspar gneisses of the so-called 'Tonalite-Trondhjemite-Granodiorite Suite'; these are thought to have originated as arc-related plutons, and to have formed juvenile continental crust.

Fig.4 Field photo of migmatitic pelitic granulite. Note the distinct pale quartzo-feldspathic leucosomes representing segregations of granitic melt. Rogaland, SW Norway.

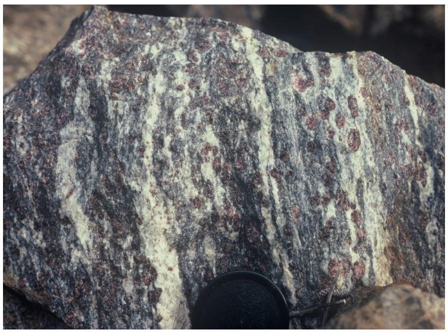


Fig.5 Close-up field photo of a migmatitic garnet cordierite sillimanite gneiss from Calabria, S Italy.

Fig.6 Hand specimen of a restitic granulite consisting almost entirely of garnet (pink), sillimanite (pale needles) and cordierite (dark patches), from Beitbridge, Zimbabwe.

Minor amounts of spectacular mafic and ultramafic granulite occur as lenses and layers within the grey gneisses. The former consist mostly of augite and plagioclase with minor orthopyroxene and/or garnet, and the latter include pyroxenites (Fig. 3), garnet pyroxenites and hornblende-spinel-peridotites. Rare metasedimentary gneisses also occur, such as pyroxene-bearing meta-ironstones. Granulites of Proterozoic age crop out in the Ox Mountains Inlier near Sligo in Eire, and in the Lewisian of South Harris.
In continental Europe, granulites of Palaeozoic age (formed during the Hercynian Orogeny) can be found in the Ivrea Zone (N Italy), Calabria (S Italy), and the Bohemian Massif (E Germany and Czech Republic).   *Giles Droop*

Report: Field Trip to Ringstead Bay 18/4/19.

We had a splendid day at Ringstead Bay on Maundy Thursday in very pleasant weather. We were fortunate that we were there at a Spring low tide exposing a lot of the rocks on the beach. Alan Holiday ran a great trip and Kelvin Huff contributed greatly. They gave us a huge amount of geological information of the area and answered our never ending questions! They are a great double act and I particularly like Kelvin's jokes!

Ringstead Bay, towards White Nothe

We walked down to the beach and looked east at the rocks dipping towards White Nothe with its splendid white chalk cliffs. The following types of rocks could be clearly seen: black Kimmeridge Clay at the base of the cliffs with Portland and Purbeck strata above. But over 70 million years seemed to be missing as there are no Wealden beds. This is yet another example of an unconformity along our coast line. Further east there is Gault and Greensand and the white Chalk of White Nothe. There are frequent landslips in the area which often cover the rocks below. Alan explained that because a of coastal protection scheme fewer fossils were now found on the beach at Ringstead. Hundreds of tons of shingle have been deposited. It used to be an excellent place to find fossils and someone on one of his early trips found a fossil lobster! The rock armour that has been used is made of Roach from the Portland stone but not good enough for use as a building stone.

We spent the morning walking westwards towards Bran Point. Kelvin and Alan started pulling out *Deltoideum delta* oyster fossils from the Kimmeridge Clay, some of which had both valves intact. These organisms lived on the soft substrate in the muddy deep seas. Huge numbers of these fossils were easily found as slumping of the cliffs keeps occurring.

Leaving the Kimmeridge Clay, we walked westwards along the beach looking at the Corallian Formation, which had been formed in comparatively shallow seas. This formed after the Oxford Clay and before the Kimmeridge Clay, both of which were deposited in deeper seas. There was a marine regression after the Oxford Clay had formed. The Corallian Formation is so called because of the coral reefs which grew around small islands in the shallow seas. The total thickness of the Corallian in this area is less than 60 metres and represents only 5 million years. During that time there must have been many climatic and environmental changes as there is a varied lithology including clays, siltstones, sandstones and limestones. The rocks were formed in the Upper Jurassic about 150 Ma.


Deltoideum delta oyster bed

As we walked westwards we were walking back in time. The upper Corallian begins with the Ringstead Coral Bed which is a thin layer but clearly seen. We noticed it was a hard cemented limestone made up of fragments of fossils which were probably broken into pieces in a Jurassic hurricane. We saw brachiopod fossils and an echinoid spine from a sea urchin. In the iron rich Sandsfoot Grit there was evidence of bioturbation including trace fossils such as Serpulid worm casts.

The Sandsfoot Clay may have been formed in muddy lagoons. Other fossils in this layer included other bivalves. Further on we came across the Clavellata Beds which were rich in *Myphorella clavellata* bivalves. You could see some of the external tubercles/small bumps on the surfaces of the two shells. Although they dominated this bed other gastropod fossils were seen such as Pinna, a type of Razor shell and ammonites. Why were so many Myophorella found in such a small area? Could it be that they were washed in from elsewhere? Alan suggested that they were probably living here together as there were different sizes but perhaps they were suddenly killed by being covered. In the cliffs we saw the Red Beds at the base of the Clavellata Beds.

As we moved on still going back in time we walked westwards towards Bran Point. We could easily identify the Osmington Oolite with its tiny round ooliths that formed in a shallow, high energy tropical seas.

The lower section of the Osmington Oolite formation was very nodular. After a pleasant lunch in the sunshine we saw huge number of trace fossils including *Skolithos* burrows and some cross-bedding on a microscale in the oolitic limestone. On the beach at Bran Point we also came across pisolitic limestone containing concretionary grains bigger than ooids. The round grains have concentric layers reaching up to 10 mm in diameter. The name pisolite comes from the Greek word for pea and that reflects its appearance exactly!

I had never come across this before and can understand why this type of rock could be polished as an attractive building stone for fireplaces. Looking eastwards we saw the Ham Cliff anticline with Corallian Bed borders and an eroded core going down to the Oxford Clay. It was quite dramatic in the sunshine. We spent the afternoon walking eastwards along the beautiful beach almost reaching the white chalky cliffs. We got better views of the Portland and Purbeck cliffs. Two of us walked up the zig-zag Smugglers path to the top of White Nothe but the rest of the group walked back to their cars. It had been another wonderful day with the DGAG.

Val Fogarty

Earth, Moon, Sun and Tides

This is just a simple account of how it works. The Earth and Moon rotate about a common centre. This is called the barycentre and lies between the centre of the Earth and its surface. It is actually the barycentre that revolves around the Sun in an elliptical orbit.

If the Moon had zero mass the barycentre would be at the centre of the Earth and if the Moon had the same mass as the Earth the barycentre would be mid way between them. Technically a moon is an object that has its barycentre within its planet so in this latter case the Moon would not be a moon.

Given the mass of the Earth ($m_e = 5.97237 \times 10^{24}$ kg) and the mass of the Moon ($m_m = 7.342 \times 10^{22}$ kg) and the distance between their centres (d_{me} = 384,402 km) the distance from the centre of the Earth to the barycentre is = $d_{me} * m_m /(m_m + m_e)$ = 4668 km from the centre of the Earth (and this is about 1703 km below its surface and lies in the mantle).

The rotation of the Earth - Moon pair about the barycentre causes a centrifugal acceleration on the Earth that is directed away from the Moon and if this was the only effect the water would bulge on the side of the Earth opposite the Moon, but the Moon's gravity pulls back and forms a smaller bulge on the side facing it - so the shape of the water is similar to that of a rugby ball (technically known as a prolate spheroid).

The size of the bulge on the side opposite the moon is larger than that on the side facing the moon and each day the Earth rotates under both tidal bulges so there are two tidal highs with differing amplitudes.

The Sun has an effect on the tides also, and although its mass is very much greater than that of the Moon it is a smaller effect (under half that of the Moon). But its effect is to increase or decrease the tides resulting from the Moon. When the Sun and Moon are on opposite sides of the Earth, or when the Moon is between the Earth and the Sun (known as in opposition or in conjunction respectively), then the tides are highest and these are known as “spring” tides and occur at the time of the Full Moon and the New Moon. Half way between Full and New Moons the tides are at a minimum and these are “neap” tides.

What is the period of the tides? The Moon rotates around the Earth in the same direction that the Earth rotates on its axis - so it takes more than 24 hours for the moon to return to the same position in the sky. In fact it takes it 24 hours and 50 minutes and this is why the times of tides change with each day.

Although we think of the tides in relation to the sea, the same processes occur to the solid Earth and the Moon and these are known as “Earth tides” and are not insignificant.

The displacement of liquid and mass have a braking effect on the Earth's rotation and this increases the length of the day slightly (currently by about 1.8 milli seconds per century - over time this adds up and in the Jurassic there were about 385 days in a year). The Earth has had a reciprocal slowing effect due to tidal dissipation happening on the Moon in its rocks and this is why the Moon has the same period of rotation as its time round the Earth and we only see one side of it. Eventually the same thing will happen with the Earth, and then the Earth will also show one face to the Moon - this situation has already been achieved between the dwarf planet Pluto and its moon Charon.

The tidal bulges on the Earth are slightly ahead of the position of the Moon and these transfer a small amount of energy to the Moon. This small amount of transferred energy moves the Moon to a higher orbit and causes the distance between the Earth and the Moon to increase at a rate of about 37.8 mm per year. *Leon Sparrow*

The Variscan Orogeny

The term Variscan Orogeny (sometimes also known as Hercynian or Armorican) is a more general term for the orogenic event which affected Europe at the end of the Carboniferous period. The orogenic belt extended from southern Ireland through south Wales, south west England and Brittany and on to the Ardennes (Belgium) and into Central Europe. The Variscan orogenic episode started with the main effects of the Caledonian Orogeny over a period of approximately 100 M.a. through to the major earth movements at the end of the Carboniferous and the early Permian. The most obvious local effects are to be seen in south west England with the folding and faulting of Devonian and Carboniferous sediments with earth movements causing low grade regional metamorphism. This was followed by granitisation, contact metamorphism and mineralisation.

Events

(1) Uplift of the Caledonian mountain chain to the north and west of the British Isles at the end of the Silurian and beginning of the Devonian.

(2) Erosion of this uplifted area with rivers flowing south off the N. Atlantic Continent (of which the British Isles had become a part with the closure of the Iapetus Ocean). The late Silurian and Devonian (Old Red Sandstone) sediments deposited by the rivers are termed molasse. These extend as far south as south Wales and north Somerset (Portishead) and are also to be seen at Marloes Sands and Freshwater West in Pembrokeshire.

(3) At the same time marine Devonian sediments were being deposited in Devon and Cornwall. These include shallow marine deposits with coral limestones around Plymouth and between Brixham and Paignton. Further west there were turbidite deposits - greywackes of the Gramscatho Beds seen south of Porthleven (Gunwalloe Church Cove and Jangy-Rhyn) and the Mylor Slates seen around St Ives Bay. These represent the flysch deposits of the orogenic cycle. In north Devon (Exmoor) there is the interdigitation of marine and continental deposits as the shoreline fluctuated north and south through time.

(4) Similar sedimentation continued in south west England into the Carboniferous with the Culm deposits seen at Bude, Millook and Crackington Haven.

(5) During the Carboniferous, compression due to the closing of the Rheic Ocean to the south, caused the sediments to be intensely folded and faulted as seen at Godrevy Point and Jangy-Rhyn in W. Cornwall and Crackington Haven and Millook in N. Cornwall. Folding is also seen in south west Wales such as at Broad Haven and Saundersfoot. The northern limit of this intense folding may be a thrust fault (Ritec Fault?) through southern Ireland, south Wales and Somerset. The intense folding produced low-grade regional metamorphism (slates with the development of axial plane cleavage seen at Jangy-Rhyn, Cornwall).

(6) To the north of this line folding and faulting was less severe as seen in the south Wales Coalfield (synclinorium) and the Pennine anticlinorium with faulting along reactivated fault lines.

(7) The closure of the Rheic Ocean caused the emplacement of an ophiolite complex in the Lizard, Cornwall derived from the formation of a back-arc basin. Lizard rocks include metamorphosed sediments (Kennack Gneiss), pillow lavas (hornblende schists at Polurrian Cove), sheeted complex (basalts at Porthoustock), gabbros and peridotites on the Moho boundary (at Coverack). These all suggest that the Lizard was formerly a piece of ocean floor.

(8) In S.W. England granitisation took place in the late Carboniferous/early Permian times (285 Ma.) and was associated with contact metamorphism which formed hornblende-rich hornfels and chiastolite slate close to the contacts (e.g. Cape Cornwall).

The granite contact at Porthmeor Cove

(9) The granitisation also resulted in metalliferous mineralisation in Cornwall with tin, copper, lead, zinc and iron ores formed. The tin and copper were directly related to the granitic hydrothermal activity, but the lead, zinc and iron were probably related to later thermal process as the granite became cooler <400°C). There is a relationship showing different ores at increasing distance from the granite and decreasing temperature. The ores occupy tension joints linked to the cooling of the granite and the relief of tectonic stress at the end of the orogenic event.

(10) Mineralisation also took place in the Pennine region not due to granite mineralisation (the underlying Weardale Granite has been dated of Devonian age). Also, the temperature of formation was probably around 150°C. Minerals include galena, sphalerite, fluorite and barytes. These resulted from circulating ground water and the leaching of rocks within a geothermal system.

Chiastolite slate, Megilligar Rocks

Plate tectonic explanation of the Variscan Orogeny

The following events probably occurred but many models have been suggested to explain the patterns.

(1) O.R.S./ Devonian major uplift and granite intrusion in Scotland and the Lake District.

(2) Molasse formation (Devonian) due to the erosion of the Caledonian mountains.

(3) Rheic Ocean subduction was occurring well to the south.

(4) A constructive margin formed in the English Channel region and the initiation of a marginal basin.

(5) This in turn caused subsidence to the north with flysch (greywacke sedimentation) and volcanicity.

(6) The flysch deposits continued into the Carboniferous with the Culm sediments.

Fold hinge and differential weathering at Duckpool showing folded Carboniferous Culm sediments (L)

Bedding and cleavage in overturned strata at Boscastle (R)

(7) Closure of the marginal basin occurred as the Rheic Ocean closed and this caused the emplacement of the ophiolite complex of the Lizard.
(8) Further compression resulted in crustal thickening and granitisation, followed by mineralisation in Devon and Cornwall.
(9) There was limited compression further north because of the rigidity of the crust giving less intense folding and faulting. *Alan Holiday*

Book Review: Landscapes in Stone

This is a series of short books introducing the geology of several areas of Scotland. They are written by Alan McKirdy, a freelance writer who is a retired former head of Knowledge and Information Management at Scottish Natural History (SNH). While at SNH, he edited the similar series of booklets "A landscape fashioned by Geology". The books (about 50 pages each) share a common layout: a short introduction to the area, a table of events throughout geological time that have affected the area and a very brief introduction to plate tectonics. The main part of the books cover, in several short chapters, the geological history with excellent photographs, photomicrographs of thin sections, palaeographic reconstructions and sections, all clearly described. There then follows a section on the area today covering the natural history and human use. The last section describes a selection of places to visit in the areas covered by each book. In summary, an excellent series of short, straightforward, introductory books. All those that I have read have had very clear diagrams and maps. If you are going to (or are just interested in) the areas covered, these small books give a great introduction. I look forward to reading more of the series.
Those published so far are: Argyll and the Islands; Arran; The Cairngorms; Edinburgh; Mull, Iona and Ardnamurchan; The Outer Hebrides; Skye; Lochaber and Glencoe.
Priced at about £7 - £8 each. www.birlinn.co.uk *John Scott*

South Wales residential field-trip report

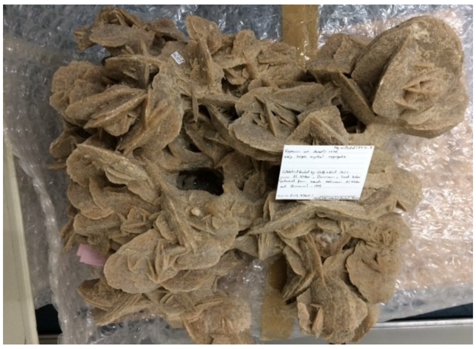
Visit to the National Museum of Wales Friday 3rd May

I was so pleased to find out that we were going to The National Museum of Wales in Cardiff as I had been there last October on an Art trip with Sherborne U3A. On that trip I went to find the geology section and found ‘The Making of Wales’, which is just brilliant. The title made me smile as it starts with the Big Bang and the creation of the Earth and then goes forward in time with film clips and displays in both Welsh and English. It has excellent fossil and rock displays as well as dinosaurs, woolly mammoths and a dinosaur trackway slab from Bendrick Rocks. A few of us from DGAG took the opportunity to see this display. We were going to see those dinosaur footprints in situ on Sunday.

We also saw the latest dinosaur find, a partial skeleton, found in the Blue Lias rocks of Lavernock Point near Penarth, which is on display near the entrance. The skull and bones of *Dracoraptor hanigani*, found only 5 years ago, are exhibited in 3 slabs. This small agile theropod dinosaur lived about 200Ma., in the early Jurassic period. It was a carnivore and they think it was warm-blooded and had fur. The genus name Dracoraptor is from Draco alluding to the dragon of Wales and the species name honours Nick and Rob Hanigan who discovered the skeleton.

We then went on a behind-the-scenes tour of the Mineral and Palaeontology Stores. Tom Cotterall showed us a number of mineral crystals and explained how important minerals are in many technological gadgets, including mobile phones. His team have classified and stored many crystals and he has received collections dating back to the Victorian age. He showed us an ammonite filled with crystals of Strontium Carbonate and a very large desert rose gypsum found in arid conditions in Saudi Arabia! (***see images overleaf)***

Part of the *Dracoraptor* display



Specimens from the mineral store

Cindy Howells then took us into the impressive fossil store and she showed us trilobites, ammonites, arthropods, plant fossils, and a limb bone of a plesiosaur with bite marks and a mammoth tooth! She took us into another room that stored many ichthyosaurs and a plesiosaur skull found by Mary Anning!

Treasures from the palaeontology store, demonstrated by Cindy Howells

Friday afternoon: The Flats, Ogmore-by-Sea (Sutton Flats SSSI)

John Scott, an active member of DGAG, was our excellent, knowledgeable leader for the next few days. On a cold Friday afternoon he introduced the three dimensions of a Triassic alluvial fan deposit. The valley of the Ogmore River is much wider than might be expected given the size of the river. The valley was widened at the end of the last Ice Age when the river was swollen by water melting from ice sheets further north. The sand in the sand dunes of Merthyr-mawr Warren is derived from glacial debris which was washed into the bay and has since been washed and blown ashore. The main period of sand movement occurred during the 15th to 17th centuries when many communities were inundated with sand. A village to the west of the bay is completely covered.

Carboniferous Limestone platform and enlarged fissure

In the early Carboniferous (360-325 Ma.) the sea flooded south Wales and a sequence of limestone of over 1000m thick was deposited in a clear tropical sea with coral reefs. The wave-cut platform of Gully Oolite, part of the Carboniferous Limestone, forms a very low vertical cliff at the top of the beach.

The limestone is highly cracked and faulted and looks very dramatic. The surface of the limestone, which is above normal high tide level, contains circular holes formed as the limestone has been gouged out by abrasion and solution. Many are full of pebbles and extend for over a metre into the rock face.

The headland on the south side of the bay is formed by beds of red Triassic conglomerates which lie unconformably over grey Carboniferous limestone. It represents a gap of 140 million years. The Carboniferous and Permian sediments in between were uplifted to form land which was eroded away before the Triassic sediments were deposited in dry desert conditions. The conglomerates represent flash flood deposits 210 Ma. that were deposited in wadis from higher land down to the desert plain. There would have been several islands of higher ground at this time and the small hill behind Ogmore beach would have been one of them. Fragments of dinosaurs and early mammals have been found there. The conglomerate in this first wadi is composed of rounded and angular pebbles of Carboniferous Limestone set in a matrix of red sand and silt. The flow of water must have varied in strength as some layers contained much bigger pebbles than others. In the north face of a wide gully we saw a very large boulder of over 1.5 metres which shows that very strong water flowed through this area in torrential storms.

Calcite veins show how faulted and jointed the rock is

Coral fossil in the limestone

Triassic conglomerate wadi deposit

Moving eastwards we came across a second wadi containing Triassic conglomerates and breccias overlying dipping Carboniferous Limestone. The deposits here are more extensive (over 1 km) and made of smaller better sorted pebbles in a matrix which is less red. The pebbles are more angular in the higher beds suggesting that these were not transported very far and the paler yellow to green colour suggests that these beds were deposited under different conditions and possibly at a different time. Veins, lining faults, and some of the pebbles are surrounded by white crystals of calcite or occasionally softer barite. Recent deposits include river gravels from 15,000 years ago. Tension gashes were seen which were caused by earth movements which tore the limestone and were filled with calcite. Other evidence of movement was slickensides at a joint surface in a bed of the limestone and diverging veins filled with calcite crystals. Some fossilised, damaged corals were seen which were probably broken off in hurricanes.

Although we were all fascinated John could tell that we were very cold so we called it a day and made our way to the Premier Inn to get some rest to be ready for the next two days of our trip.

Val Fogarty

There will be further field reports from the South Wales weekend in the Autumn edition of the Newsletter. This is a good place to thank all contributors to this issue, and it's nice that I already have material for the next edition. I welcome all contributions but it would be especially good to hear from those members who live outside Dorset, there must be geology nearby!

Deadline for the next issue is Monday 26th August. *Kelvin*

DGAG Field Trips and allied events 2019

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

Thursday June 20th: Haytor and Dartmoor. Leader: Alan Holiday.

Thursday 4th July: Lyme Regis area. Leader: Geoff Townson.

Saturday August 17th: Portishead. Leader: Alan Holiday.

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

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

September (date tbc): Exmouth and Budleigh Salterton.

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.

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

Saturday November 16th: DGAG Annual Dinner. Guest Speaker: Dr. Jon Murden

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.

19th–24th June: Geology of the Isle of Man. David Burnett and David Quirk

7th July: Geology and archaeology walk, Abbotsbury area. Kelvin Huff

August 8th: Oceanic Cores of Volcanic Sediments. A visit to the laboratory of the British Ocean Sediment Core Research Facility. Millie Watts

11th August: Graphic logging, Upwey. Fiona Hyden

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

Reminders: Contributors' deadline for the Autumn Newsletter is **Monday 26th August.**

Committee news:

We still need an Events and a Fieldtrip Officer!

Kelvin

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