KENT GEOLOGISTS' GROUP

The Kent Group of the Geologists' Association

KGG
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NEWSLETTER

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Website: www.kgg.org.uk

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THE KENT GEOLOGISTS' GROUP IS A LOCAL GROUP OF

THE GEOLOGISTS' ASSOCIATION

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As a local group we receive details of lectures and field trips organised by the GA and other Local Groups and Affiliated Societies. Copies of the GA Magazine and the Circular with these details are on display on the Secretary's Table at all Indoor Meetings.

MEMBERSHIP OF THE KENT GEOLOGISTS' GROUP

Membership is open to all who have an interest in geology, regardless of qualifications and experience. The annual subscription (which runs from January to December) is £15.00. There will be only one mailing to each address.The subscription for each Additional Member living at the same address is £2.00. There is an entrance fee of £1.00 per meeting (£3.00 for non-members).

Membership application forms may be obtained from the General Secretary or downloaded from the Kent Geologists' Group website:- www.kgg.org.uk via the "How Do I Join" page.

Editorial

Welcome to newsletter No.24, I hope that you all find something of interest in its content.

I believe that a newsletter should consist of members' reports on activities that have taken place since the last issue, either singly or as a group; news of absent or past members; details of coming events or anything that other members may wish to know about. In summary a newsletter should contain articles that tend to bind members through their common interests.

For that reason I am most grateful to Alison Taylor for providing our principal article in this issue The article contains local geological information and is based on her personal experience so I hope that you will find the article as interesting as I did. I am also grateful to Peter Austen for supplying details of the prestigious award made to Ed Jarzembowsli in China and to Tony Mitchell for his recollections of working with Ed since the earliest days of the Kent Geologists Group.

Cover picture: Hadrian's Wall, started in 122 AD and built across the width of England, was probably intended to control movement across the boundary of Roman occupied Britain. A natural defence was achieved by placing the wall where the Whin Sill surfaces to produce a steep escarpment.

The year 2015 has been a good one. Though the membership was the lowest it has been since I joined we have been fortunate to gain as many as twenty or so new members over the last few years, many of them young and really enthusiastic. Unfortunately, young members are usually in their last year at school or waiting to go to university. This makes them mobile, so that they seldom stay with us for long. After graduation their careers often take them away from the area where they grew up or were educated.

At our AGM in March Anne Padfield celebrated completion of her first year as Chairperson. We thank her for taking on the role when Adrian Rundle retired after sixteen years as Chairman. During her first year Anne led three walks for the Field Meetings programme, all well attended and popular and chaired a similar number of committee meetings. After participating in the Yarwell weekend last year,she wrote an article on the geology of the Collyweston slate for the last newsletter. As if that were not enough she has submitted a poem for this issue of the newsletter. In common parlance “She has hit the ground running!” and is setting an example for us all.

Thanks are due to Ann Barrett for once again arranging a varied programme of good and popular speakers for our indoor meetings. Talk subjects ranged from the ‘The Silk Road’ and ‘Rocks of Arctic Canada’ to ‘The Building Stones of Medieval Sussex’ and ‘Water for Africa’ - something for everyone and varied indeed! We also thank Mandy Bird for handling the domestic arrangements.

Having no Field meetings secretary, the group had to make its own arrangements for field meetings and the result was a credit to those members who arranged events for our enjoyment

In February, Adrian Rundle held two microfossil workshops at his home in Richmond but sadly no KGG members attended. Having attended several of these workshops myself I can recommend them as an excellent day out. There is usually a microfossil theme, e.g. Ostracods or Foraminifera, for which Adrian will have written a detailed booklet. There is ample opportunity to sort through shell-sand samples and make slides to take away. A free salad lunch is provided with one of Adrian’s celebrated fruit salads to follow containing up to thirty different fruits; but beware, Adrian will expect you to be able to identify them all! Members who have not joined one of these workshops don’t know what they are missing!

Adrian also took his ‘Activities’ tables to three two-day ‘Rock ‘n’ Gem’ shows at Kempton Park and also to the GA Festival of Geology at University College, London. We are indebted to Dennis Fullwood who has, for many years, transported all of the material from Adrian’s house to the event then back again.

The lack of support from members for these events is very disappointing, especially as Adrian provides all of the materials at his own expense, and free donations made by the public are a significant proportion of the Group’s annual income!

Andy Temple organised three Fossil Forays to Folkestone Warren in conjunction with GeoConservation Kent and the White Cliffs Countryside Partnership and Peter Austen again lead two visits to Smokejacks Brickworks in Surrey. Alison Taylor, becoming a regular leader, organised another walk in the vicinity of her home near Stowting; this time to learn about ‘The Monks of Monks Horten’ (and to take some of her llamas for a walk!).

As if being Chairperson were not enough, Anne Padfield organised two events in 2015, a walk from Tyland Barn, the head office of the Kent Wildlife Trust and a ‘Medway River Drive’ from the Malta Inn at Aylesford. About ten members joined the walk and thoroughly enjoyed it (for a report see the KGG website - Fragments page). The drive had to be cancelled because of members’ other commitments.

As we have no Field Meetings Secretary I think you must agree that we have been served extremely well and, on behalf of all members, I thank the leaders for their efforts.

At the Annual General Meeting (AGM) in March we had to make some hard decisions about the group’s financial situation. To remain solvent we had to increase the annual subscription and also make a charge per meeting; a change that many other groups have also had to make. The cost of hiring the hall, which can hold up to one hundred people (our membership just a few years ago), has to be paid whether occupied by one hundred or just twenty people. The hall hire is less than at our previous meetings location, the facilities are much better and we could not have been made more welcome by United Reformed Church. The situation we face emphasises the need to keep our membership numbers as high as possible so that subscriptions may be kept at a reasonable level.

Finally, I cannot close this editorial without offering a special ‘Thank you’ to Ian Thomas, Project Manager with Pevensey Coastal Defence Limited. On being asked for permission to reproduce the picture of high seas in Pevensey Bay in Alison’s article “Shingle in Motion”, Ian sent a full resolution original with details on where the picture was taken and the date, by return email!

Shingle in Motion

A profile of The Crumbles and its role in the development of Pevensey and Willingdon Levels.

Alison Taylor

In the county of Kent there are two outstanding coastal features, namely the White Cliffs of Dover and the great shingle spit of Dungeness. In Sussex, my native county, we have Beachy Head, (much higher and more impressive than the Dover cliffs!), and The Crumbles, a shingle spit of quite modest proportions, but interesting none the less. A recent visit to my hometown of Eastbourne prompted me to write this article.

The Crumbles can best be seen in its entirety from the top of the South Downs, just to the West, above Eastbourne. It protrudes only one modest mile out to sea and so its presence could easily be missed by the casual traveller. The base of the promontory stretches for about four miles along the coast from Eastbourne to the village of Pevensey Bay and the seaward tip is called Langney Point. My interest is particularly in the Crumbles, but there is little value in writing about this shingle spit in isolation, without considering how it, and the build up of beach material from Pevensey Bay to Cooden, have affected the immediate hinterland. I'm afraid that the length of my article has increased accordingly!

The Crumbles is composed of shingle, predominantly flint; its surface a regular parade of parallel fulls – the time degraded storm ridges of pebbles thrown up by the sea over many years. During the centuries of its existence an amazing number of wild flowers managed to gain a foothold in this rather unpromising environment; a multicolour carpet of viper's bugloss, valerian, ox-eye daisies, yellow horned poppies and many, many more, with always the muted colours of the flints to show them off. Flowers attract insects and insects attract birds. It was, in short, Dungeness in miniature.

It boasted one single track road out to Langney Point, and another from there, along behind the shoreline to meet up with the east end of Eastbourne seafront. Local people walked or cycled on this track to go fishing, swimming or to gather drift-wood. Children explored freely, rode their bikes, made camps, caught grass-hoppers, picked flowers and blackberries and had picnics in the sheltered hollows.

In various different parts of the Crumbles there were features demonstrating its history. A parade of Martello Towers strode along the coast and, just on the north-east side of Langney Point, the steel skeleton of the merchant ship Barnhill protruded starkly from the sand,a 1940's casualty of German bombs, whose misfortune was the good luck of the local people, who enthusiastically gathered up a war-time bonanza of tins of food, cheeses, rolls of leather and parachute silk etc. which had spilled out of the gash in ship's hold.

To the north-east of the Crumbles track were deep, fenced off, water filled pits where shingle extraction was ongoing, while on the south-west side a mass of scrubby bushes and dwarf trees grew in an area where shallow extraction had stopped at the level of the water table many years previously. A low concrete wall running all the way to Eastbourne, showed where a single track railway, the Ballast Line, had operated from 1850 to shortly before the Second World War, ferrying truck loads of shingle to the main railway network where it was used to form the base on which new railway tracks were laid down. All these activities had added character to the Crumbles over the years without seriously impacting on the environment.

The Crumbles was formed by the action of the sea, and as such is a very young feature in geological time; even a young feature in the history of man. It seems certain that, at the time of the Roman occupation of Britain, there was no vestige of the shingle accumulation which became the Crumbles. Not until the Norman landings in the 11th century do records suggest that changes were taking place along the coast between the chalk cliffs to the west of Eastbourne and the Tonbridge Wells Sandstone hills running down to the coast at Cooden and Bexhill.

This, however is recent history. To set the scene in a more comprehensive context, we must go back 10,000 years to the final centuries of the last Ice Age, when, with huge amounts of the earth's water locked up in the ice sheets, the sea level was vastly lowered, resulting in Britain being an extension of the land mass of continental Europe. There was no coast to the South of Kent and Sussex, but just a broad valley between us and France which accommodated the Solent/Seine river system, draining westwards to the Atlantic Ocean. This river system was fed with melt-water from the edge of the ice sheet in the east and the north and also with run off from the warmer lands to the south. As the climate warmed and the ice melted, the rising water level completely changed the southern borders of Britain, introducing the sea as a new and important factor in landscape development.

Aerial erosion had already impacted on our varied Wealden geology, leaving higher areas of the more resistant chalks and sandstones, while wearing away the softer clays and silts. Therefore, when the sea level rose, and flooded the channel from side to side and end to end, the resulting coastal scenery varied greatly along its length. In some locations small rivers had significantly lowered the level of the land, allowing the sea to flow in and cover quite extensive areas making shallow bays and inlets. One such was the precursor to the Crumbles and the Pevensey Levels.

Excavations and boreholes have provided samples of layers of sand and silt beneath the more recent ones, demonstrating extending sandbanks in the mouth of the bay and a build up of river silt behind. Tides and wave action operated then in the same way as they do now. Sand would have been moved along the coast most effectively from west to east by the larger waves from the Atlantic, and there was plenty of loose material, associated with the old river system, on the floor of the Channel to be churned up by storm waves and sent towards the shore. More eroded material was constantly being introduced by the rivers entering the bay and, as the rivers and marine currents came in contact with each other, sand and silt would have drifted down to the bottom in the ensuing hiatus in the smooth flow.

Evidence shows that, in this way, the Willingdon Levels on the Gault Clay on the western side of the bay, were cut off from the sea and silted up to such an extent that hazel and pine trees and then oak and elm trees were able to grow to form a woodland. After many centuries, circumstances changed and the land that had built up as a result of marine processes, was destroyed and swept away by the same agents. The bay remained open to the sea for another 4,000 years before the same process of extending sand bars and silting of the protected bay took place all over again. Inevitably, once more the bar was destroyed and the bay scoured out, and so it was that, when the Romans arrived 2,000 years ago, the mouths of the bays between the Chalk and Greensand and the Greensand and Tunbridge Wells Sandstone were wide open, forming a large area of sheltered water, extending about 10 miles inland.

For the Romans, this bay would have provided a very handy area of sheltered water in which any number of boats could moor in safety. The remains of a Roman villa were found many years ago near Eastbourne pier, but the most important of their constructions, and still a dominating feature in the landscape, was their fort Anderida – a huge wall built typically in the Roman style of stone, tile and brick, surrounding the end of a Weald Clay and Tunbridge Wells Sandstone promontory into the west side of the bay. It was built around 330 A.D. and is the largest of the Saxon Shore Forts, whose purpose was, supposedly, to help protect south-east England against Saxon invasion. The Classis Anderitianorum, an important division of the Roman fleet, anchored here, and there was plenty of space inside the Wall for detachments of soldiers to set up camp. In the 5th century however, as the Roman legions were called back to Rome, the Saxons got the upper hand and were able to gain possession of Anderida.

The human story moved on, but the geography of the area remained the same – the broad inlet in the coast still reached inland over the eroded basin to the clay and sandstone shores. There were other thin necked promontories reaching into the bay besides that of Anderida – now renamed Pevensey by the Saxons. (The ending of 'ey' or 'eye' to a Saxon place name denoted an island site.) To the south-west of Pevensey was Langney, (Long Island), part Weald Clay and part Lower Greensand. Rickney was at the tip of a Weald Clay promontory in the north-west of the bay. There were also several true islands. Chilley, a small island of Tunbridge Wells Sandstone rose 10 metres or so out of the water between Pevensey and Rickney, and the Weald Clay island of Horse Eye reached a similar height in the middle of the northern part of the bay. One island in the very south-west of the bay, bordering on the shingle of the Crumbles, is an exception to this similarity of names .It consists of Gault Clay and is where I was born and lived as a child. It is called St Anthony's Hill.

In the north-east part of the bay, behind the present coastal village of Normans Bay, lay an island consisting of three humps of Tunbridge Wells Sandstone and measuring nearly a mile long. This was Northeye. Half a mile to the west of the current site of Normans Bay was the island of Southeye which is partly Tunbridge Wells Sandstone and partly Weald Clay. Its position was right at the edge of the bay and its south-eastern edge is cliffed, presumably as a result of wave action. This part of the island is called Rock House Bank. I imagine that people lived on all these islands in the sheltered and, no doubt, fish rich bay. On Chilley, Horse Eye and Southeye there are currently farm houses, but on Northeye there was, for centuries, an entire village.

The Saxon settlements were not left in peace for long before they in turn began to be threatened by the Danes, but still the bay remained, and still Pevensey was a very important harbour and port. For at least 1,000 years after the Roman invasion it seems that the coastline here remained fairly stable. Then, in

1066 the Normans arrived. No-one knows exactly where they landed to offload their huge force of soldiers and horses, but this was no quick operation. Maybe they landed on the sea coast between Cooden and the Hastings cliffs, or maybe somewhere within the bay where there was shelter from the open sea. We do know, from this point on, the details of their rapid overthrow of the existing regime and way of life. The Normans, recognising the attributes of Pevensey as a port, were quick to build a strong castle within the existing Roman walls, but the surrounding area was beginning to change.

Little by little, a quantity of flint shingle from the cliffs further west, and probably also from offshore shingle banks, began to accumulate on the shore of what is now Eastbourne. Slowly, but inexorably, by long-shore drift, it started to creep north-eastwards, beginning to enclose the western part of the bay; now Willingdon Levels.

How fortunate for modern researchers that the Normans were great record keepers, for it is to a large extent through historical writings that we can catalogue the physical changes in the landscape. The accumulating mass of shingle was named in early Norman records as 'La Cromble'. A pond or lagoon is mentioned in 1280, trapped behind the extending shingle, where fish were kept for easy capture for the Norman table. It is shown again on John Speed's map of 1610 in the same position as the existing Princes Park boating lake, behind the eastern end of Eastbourne sea front. Ditches draining Willingdon Level feed the pond which exits through a lock-gate and then a pipe through the shingle ridge and so to the sea.

Small streams ran into the bay from the clay and sandstone hills around its perimeter and, as the shingle extended further across the mouth of the bay, cutting it off from scouring waves and currents, the silt brought down by these streams gradually settled on the bottom, reducing the depth of the water. Norman records tell us of numerous salt works on the growing marshes at the edge of the bay. The small village ports around the bay which had been partly sustained by the transit of iron from the Weald, gradually lost their position on the coast, and as time went on, access to the major port of Pevensey became restricted to a river and finally, by the 16th century, it became completely land-locked. Thus, like Camber Castle, its reason for existence eventually ceased and it was abandoned.

The shingle did not just move right along the coast to Cooden. It also began to extend out to sea in a huge bulge constructed of storm ridge after parallel storm ridge, all trending from south-west to north-east. Why did it accumulate so vastly in this particular location? How was it enabled to do so? Perhaps there was a rich source of shingle just off-shore in a position where strong currents deflected by Beachy Head could move it along to add to the shingle brought along by the regular long-shore drift. Certainly there were sand bars in the bay, some of which would have been partly exposed at low tide. Shingle could have washed onto them and thus gained a foot-hold. Standing on the shingle of Langney Point above the entry of the marina at low tide, you can see the junction between shingle and sand where the channel from the sea was excavated. At this point the depth of the shingle is about 6 metres.

This extension out to sea seems to have occurred quite rapidly as it does not feature in records before the 16th century. In 1587 a survey of the South coast was made, to pinpoint possible danger points for invasion by the Spanish fleet. At this time Langney Point was recorded as projecting 3km out to sea. In 1648 Blean's map shows a similar extent of shingle. However, this appears to have been its maximum size, as later maps show a gradually reducing profile as the shingle was moved further north-eastwards along the coast. By 1724 the point extended only 2.1 km out to sea, reducing to 2km in 1778, by which time the point had migrated 250 to 300 metres to the north-east.

Between 1805 and 1808 a series of Martello Towers was built all along the south-east coast of England to counter the threat of invasion by Napoleon. By 1818 the three towers on the west side of Langney Point had been undermined and destroyed by the sea, this being where the most serious erosion was taking place.


Fig 1 Martello Tower No.64

In 1840 a Harbour Commission map was produced. This showed the shingle point to extend for only 1.4km, and to have been shifted a further 500 metres to the north-east, as the long-shore drift continued to move the shingle from the west to the east side of the tip, and, incidentally, further along the coast to feed the beaches of Bexhill, Hastings and Dungeness.

In 1876 the Ordnance Survey 6 inch map shows the extent of Langney Point to be only 1.35 km and in the 1899 edition it is further reduced to 1.28 km. Thus, in three centuries, the seaward extent of Langney Point was reduced to less than half of its size in the 16th century. No wonder there were problems with shingle diverting or blocking river mouths further east along the coast.

Throughout these centuries of beach movement on the coast, the silt in the now enclosed bay behind the shingle spit continued to build up. The islands in the bay gradually lost their fishing resources and people had to adapt to the changed nature of their surroundings. Life must have become difficult and uncertain.

On the island of Northeye, in the very north-east of the bay, a mile north of the current village of Normans Bay, there was a flourishing village, complete with church and all the other facilities of village life. Northeye features as a contributor to the Cinque Ports in a 1229 document held at Rye. The marsh started to be drained but progress was periodically frustrated by incursions of the sea when the shingle spit was breached by storms. There were also periods of flooding when river exits to the sea were blocked by the north-eastwards migrating shingle, and new exits had to be dug by hand to get rid of excess water. Also, the drainage of one area affected the stability of the systems of adjoining areas. There were opportunities for people to improve their livelihoods by draining and cultivating the land, but there were as many losers as there were winners. The movement of shingle along the coast was a constant problem.

Two main drainage systems gradually developed, Pevensey Haven to the west and Wallers Haven to the east, though most of the water in Pevensey Haven was diverted eastwards along behind the shingle spit to exit at the sluice at Normans Bay as this had fewer problems with shingle blockage than the original Pevensey Haven exit to the west. When Wallers Haven was dug out, it drained away all the water from the Northeye haven leaving the village with no port facility. The export of Wealden iron from Northeye had been its lifeblood and, and without this trade to sustain it, the population gradually dwindled. By the end of the 17th century it was totally deserted, a portion of the population moving to the shingle ridge near the sluice and forming the basis of the village of Normans Bay.

Since the beginning of the 20th century, groynes have stabilized the foreshore and minimised the movement of the shingle. These are more massive and closely spaced on the south-west of Langney Point, where they are most needed. To the north-east the groynes are fewer and further between and here the authorities regularly move shingle from the Cooden end of the beach back to more vulnerable places near Normans Bay. In fact, Winter storms frequently bring anxiety to the people who live along the coast between Pevensey Bay and Cooden. (See figures 2 and 3 below).

Fig 2. Rough Seas at Pevensey Bay

Fig 3. Restoring the Sea Defences

At no point along this shingle coast does a river flow naturally into the sea. The water drained from the marshes is controlled by sluices at Normans Bay and just to the east of Pevensey Bay village and is then piped into the sea. On the south-west side of Langney Point, the erosion by the sea has truncated the ends of the storm ridges and here the beach falls much more steeply into the sea than on the north-east side, where the beach slope is quite gradual and a small amount of sand is visible in some places at low tide. The steepness of the beach on the west side allows much more damaging waves to break on the shore, and of course, is the direction from which the largest and most frequent waves come.

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So, have we tamed the sea? Has Langney Point been secured in its final extent and position and will the Pevensey Levels forever remain that tranquil pastureland for sheep and cattle?

For the moment, the situation seems to be reasonably controlled and, in recent years, a good deal more scientific investigation and long-term planning has gone into the problem of erosion around our coasts. Certainly a great deal of money has been invested in developments on the Crumbles, so there must be confidence in the coast's security there. However, although we might be equal to what nature throws at us under normal circumstances, rising sea levels pose an increasing problem over time and we are ultimately totally powerless in the face of major events in the life of our planet.

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When I was growing up on St Anthony's Hill in the 50's and 60's, the face of The Crumbles was as I described at the beginning of the article. We cut sprays of pussy willow for our Mums in the Spring-time from the watery scrubland, picked flowers in the Summer and blackberries in the Autumn. We went swimming and beach combing near the Point, and, on Christmas afternoon, met many of our neighbours as we walked off our Christmas dinners on an excursion to the sea and back.

The Pevensey Levels remain a quiet back-water of reedy dykes and sheep dotted pasture land, but The Crumbles as I knew it is no more. During the late 1960's, work was started on building houses along the landward edge of the shingle, and, over the years, a growing housing estate has covered every inch of the old shingle ridges to the south-west of the Crumbles track, to within 100 metres of the sea. To the north-east of the old track, the lagoons made by shingle extraction have been extended towards the sea and are now a marina with boat access just to the east of Langney Point (See Figure 4). Around the marina basins and along the coast towards Pevensey Bay are a closely packed maze of high rise , classy flats, making a type of canyon landscape where you can see nothing but brick and concrete to left or right. You can catch neither sight nor sound of the sea unless you can find one of the tiny alley-ways between the buildings which look as if you are probably trespassing on private property. The developers have saved a stretch of shingle ridge about 50 metres long as a token of The Crumbles former glory. To me it looks like a tiger in a cage.

Fig 4 The Marina Entrance near Langney Point

Many thanks to Geoff Downer, Anne Padfield and Tony Mitchell for your help in furnishing me with geological maps and a book to complement the maps.

If you would like to read more about The Crumbles, there is a very good book full of beautiful and interesting photographs called 'The Crumbles Story' by Ann Botha.

The ISBN number is: 0.9553475 – 0 5.

Figure 1 below shows an area of the Sussex coast north and east of The Crumbles, approximately 10 miles east to west and 8 miles north to south. All dimensions are approximate. Only the major elements of the drainage system are shown. There are, of course, hundreds of small dykes criss-crossing the marshland. Figure 2 shows an area approximately 2.5 miles west to east and 2 miles south to north - The Crumbles as I remember it in the 1950s and early 1960s. The marina now occupies the area around the old rifle range and houses and flats cover the entire area where the ridges are marked.

Editors Comment

Some members may wonder, as I have, why moving shingle from the place where the sea deposited it back to where it started is the technique used to maintain the sea defences at places like Pevensey Bay when one might think that a concrete wall would provide a more substantial barrier to the sea.

For justification of the 'Soft' coastal defence system applied at Pevensey, and much more about the dynamics of beaches, members should visit the Pevensey Coastal Defence Ltd website at:-

http://www.pevensey-bay.co.uk/feature.html

The sketch maps below show, in their geological setting, The Crumbles and extended shingle bank enclosing the alluvial Pevensey and Willingdon levels.

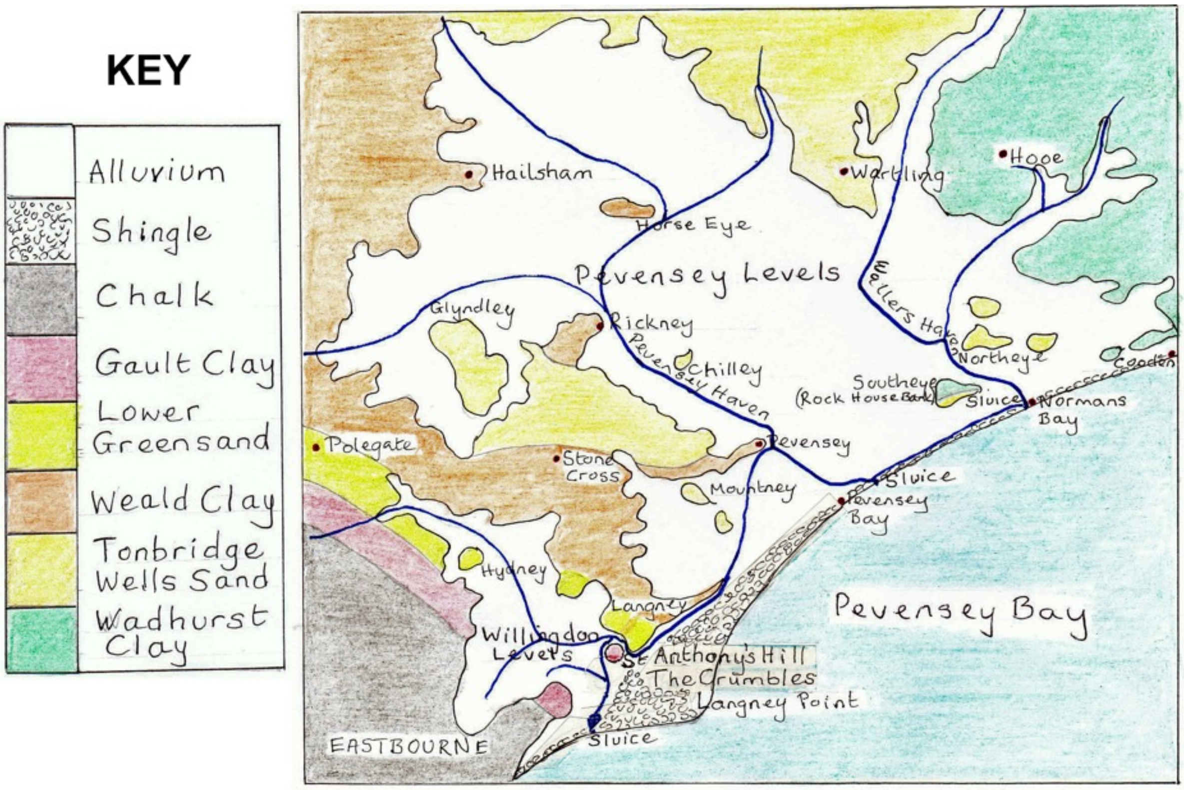


Figure 1 Eastbourne to Pevensey

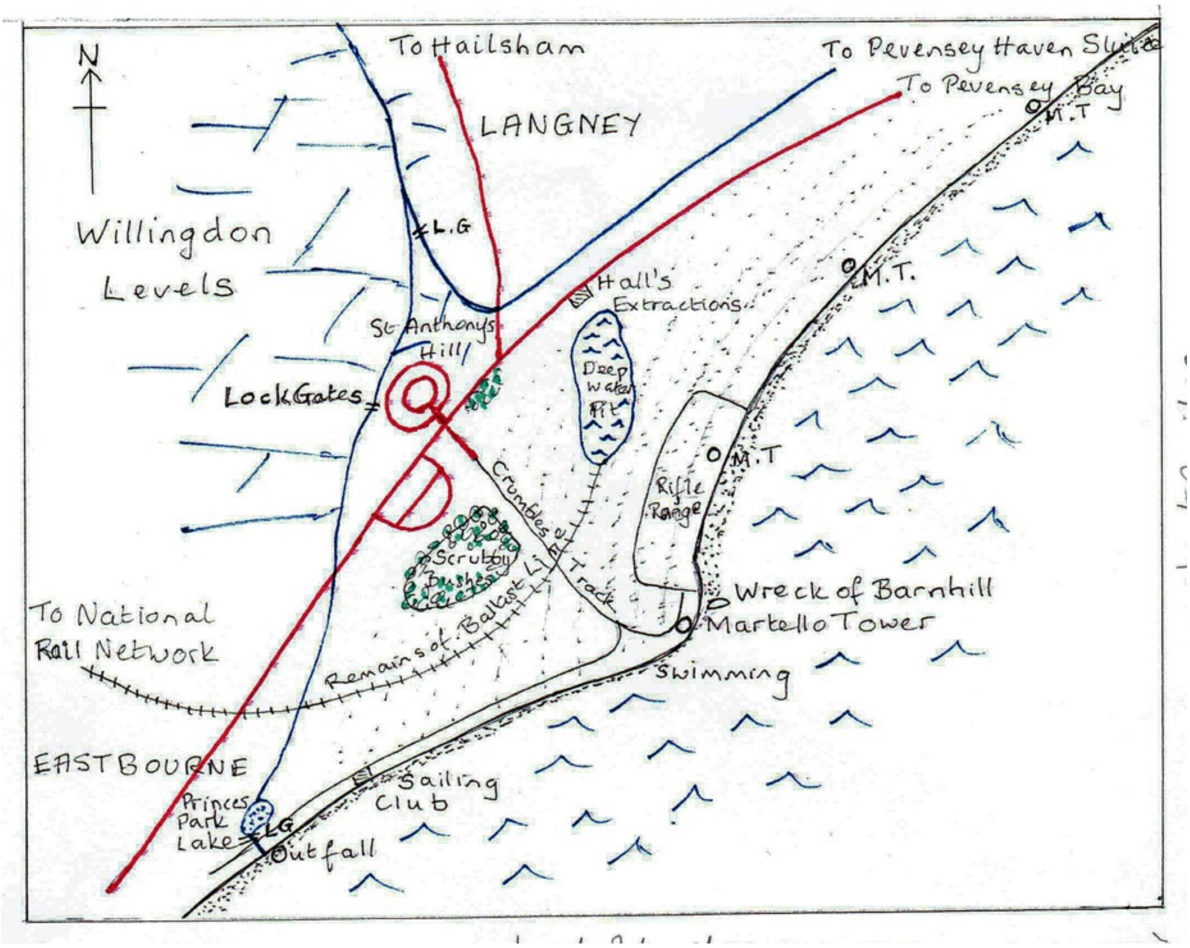


Figure 2 The Crumbles in the 1950's and 60's

Water for Africa

John Taylor

If you were asked "what is the most precious mineral on the planet?" what would you reply, gold, platinum, diamond? You would be wrong – it is water! If deprived of water each of us would die in a very short period of time.

You may think that there is no risk of running out of water, after all two thirds of the earth's surface is covered by water. The major oceans are as deep as the mountains are high! - But sea water is salt water. Drink too much of that and you would also die. For human consumption we require clean water and the major source of that is rain.

Water can exist in three physical states, solid (ice), liquid (water) or gas (water vapour). Sunlight causes water to evaporate from the sea as water vapour that gathers as clouds and is transported by wind. As altitude increases the temperature and pressure both fall; the ability of the clouds to retain water decreases and the excess water is deposited as rain. Rain that falls on the land makes its way back to the sea by way of streams and rivers – a fact seemingly unknown to some authorities in low-lying areas who, having built reservoirs to store water, build flood barriers to prevent flooding! To prevent flooding we need well designed and maintained drainage ditches to convey the excess water towards the sea. In the past, rainwater and locally sunk wells have been our only source of clean, drinkable water - but we can only use it at the rate it falls and much of that water evaporates or seeps away into the ground. We have built dams and reservoirs to store water so that it is always available, especially in periods of drought. One would think that such a precious resource would be protected and used wisely.

Our early predecessors lived simple hard lives. They were close to their surroundings and intimately aware of their relationship with it. They knew where everything came from. It is a sad fact that civilisation has dimmed our senses and reduced our knowledge of important things that can seriously affect us. Ask someone where their food comes from and they may well reply "the local supermarket". Our food comes wrapped in plastic, reducing to a minimum information on its origin, the processes it has gone through and its journey to us. Our water comes from a tap, pure water piped right into our homes. So blasé have we become that we think of it as an unlimited source. So reckless have we become that we spray it over our gardens and cars, fill our swimming pools with pure, clean water, totally oblivious of the fact that millions of poorer people in under-developed countries are dying of thirst, or of disease caused by drinking contaminated water.

A few years back we were shaken by the introduction of the "Hose-pipe Ban". Some people in hard hit areas had to get their water from standpipes. Suddenly we realised that this precious resource had limitations and we were in danger of using it at a greater rate than it became available

In July this year the monthly talk was given by Sandy Elsworth; the title was "Water for Africa" and it was one of the most interesting and informative talks we have had.

Sandy grew up in Zimbabwe and saw first-hand the hardship of people living in a harsh environment with very little water. He studied geology, became a hydro geologist and has spent his working life prospecting for sources of ground water, installing, maintaining and repairing bore holes. Ground water has become his passion and one has to feel passionately about something if one is to make an impact on it.

Starting with a few questions for his audience Sandy established some simple basic facts that surprised many of us:-

- 97% of water is sea water, only 3% is fresh water that is drinkable.
- Percentages of fresh water break down as follows: 69.6% is icebound; 30.1% is groundwater, for which a borehole or well is required; 0.3% is surface water, i.e. streams, rivers, lakes, or man-made reservoirs. Another way of expressing this is that groundwater accounts for 99% of potentially available (non-icebound) drinkable water, and only 1% is surface water directly available to us.

When searching for new supplies some estimate of the need is a useful starter. Sandy gave us the following average current consumption figures:-

- The USA: 450 litres/person/day
- The United Kingdom: 150 litres/person/day
- Target for Zimbabwe: 45 litres/person/day

Already the USA faces a water crisis and some remedial action is required, e.g. reduce consumption or drill more bore holes.

While ground water is currently by far the greatest source of drinkable water it must be remembered that it has been deposited over millions of years and, if we discount wells, we have only recently started to tap into it. As a major source it is important to know the rate that it is being ‘topped up’ by seepage from the surface if we are not to exhaust it and finish up in a worse predicament than our present one. It is the equivalent of money in a bank account deposited over many generations by our predecessors. If we are wise we will spend only the interest, or the amount by which it is topped up, except in emergencies. This means that the borehole water levels have to be monitored continually to manage the resource.

Sandy spent a great deal of time travelling in East Africa and especially his native Zimbabwe, carrying out geological surveys for potentially available ground water and researching the current bore-hole situation. Eastern Zimbabwe is virtually all granitoid rock – it doesn’t hold much water! The most likely sources of ground water would lie in the porous Greensand belt running roughly SSW to NNE between Bulawayo and Harare.

Water borehole depths are typically between 50 metres and 120 metres, but do reach depths up to 500 metres (Addis Ababa is an example).

Borehole lining is generally plastic these days, but steel and stainless steel are still used where necessary depending on the size of hole, water type, and depth, etc.

When visiting existing bore-holes Sandy found that less than a third were producing water. The most common explanation he was given was that the source had run dry and another bore-hole had been sunk nearby. He pointed out that if the source had genuinely run dry sinking another hole close by was hardly likely to be successful. On examination, the failure was more often found to be a blocked bore-hole, failed liner, pump failure or an electrical fault – all of which could be detected and rectified by regular inspection and overhaul as part of an Integrated Maintenance Plan. Sadly, the skills required for these activities are not readily available in some of the poorest areas where water is most scarce. Providing education and technical training in these areas is important and is one positive way in which the richer nations can help

Sandy moved to the UK around twenty five years ago. He worked for South East Water for nineteen years before becoming an independent consultant. Having seen the effect on people’s lives of an inadequate supply of drinkable water, researching supplies and making them available to those in need has become his passion. This passion and enthusiasm came across in his talk and are best summed up in Sandy’s own words.

> “My key point is that understanding the geology and hydro-geology of groundwater, and managing our groundwater resources, is a critical aspect of our adaptation to climate change, and indeed, ensuring ...perhaps.. the survival of our species!
>
> Very often is it "out of sight, out of mind" especially with respect to groundwater. Therefore a call to reassess our relationship with the earth, rocks and the benefit they provide for supporting life is essential.”

In the UK we are blessed with clean air, an adequate supply of drinkable water, a mild climate and fertile soil. It is time we started to make these blessings known to the general public, to appreciate and safeguard them, use them wisely and to turn our thoughts to the needs of others less fortunate than ourselves.

We thank Sandy Elsworth, for his talk on ‘Water for Africa’. His passion for drinkable water was a timely reminder that, to survive, we need to value and protect our environment.

Editor’s Note:

Boreholes have a very long history and a great number of uses. The Chinese sank boreholes to depths of up to 200 metres as long ago as 200 BC. The British Geological Survey (BGS) holds records of boreholes that were sunk in the early 1700s.

Ref: www.bgs.ac.uk/data/boreholescans/docs/borehole.pdf

A Teesdale Holiday

John Taylor

Sir Thomas Beecham once said "*The English may not like music, but they absolutely love the noise it makes*". A similar comment could be made about me and geology; I know little about geology but love what I see! Though I am interested in geology I have never studied it as a subject at any level. At the age of eleven I even gave up geography to study mathematics and the more physical sciences on which my career has been based. However, one cannot escape geology; it shapes the very landscape in which we live giving much of the attraction to the holiday locations we love to visit. It determines the types of plants that grow and yields the fossils and minerals that many of us collect.

In August 2014 my grandson married his fiancé who was born, and lived all her life, in County Durham. The ceremony took place at Stocksfield a few miles west of Newcastle. I have travelled to many parts of the United Kingdom from Cornwall in the west to Norfolk in the east, from the south coast to Inverness in Scotland and through much of Wales. However, I had never been to Northumberland and Durham, though I have travelled through the area many times by train.

We decided to combine the wedding with a one week holiday in the area. Thus we could attend the wedding and also see as much as possible of the countryside. We walked part of Hadrian's Wall, visited Housteads and Chesters and visited Beamish, 'The Living Museum of the North' (for which one has to buy a one-year season ticket!). However I think we were most impressed by the beautiful countryside. We decided that we had to return to the area to see more of it.

In early May this year we spent a one week holiday near Mickleton, in Upper Teesdale. On arrival we were greeted by intermittent sunshine and showers and distant snow-capped hills but the countryside could only be described as 'stunning'. Teesdale is renowned for its open moors, steep sided valleys, fast running clear rivers and fabulous waterfalls. It is part of the North Pennines Area of Outstanding Natural Beauty (AONB) and, at 1983 square kilometres, is the second largest AONB in England and Wales. It is the underlying geology, water and rocks that shaped this much-loved landscape.

About 320 million years ago, in the Carboniferous period, Teesdale lay at the bottom of a sea and close to the equator. The seabed was built up of layers of mud, sand and calcite shells (the remains of countless sea creatures). In the mid-Carboniferous period, under great pressure, this was compressed then uplifted to form the Great Limestone member, part of the Alston Formation, the older member of the Yordale Group.

The second geological event that shaped the landscape occurred about 295 million years ago. Quartz Dolerite magma rose towards the surface and spread sideways between strata in the sedimentary rock to form a tabular layer of igneous rock known today as the Great Whin Sill. The Great Whin Sill stretches from Teesdale northwards to Berwick on the England/Scotland border and is approximately seventy to ninety metres thick. Much of the early developments in geology occurred in Britain and terminology has derived from terms used by early quarrymen. 'Sill' was the name given by them to a horizontal body of rock and 'Whin' was the name given by quarrymen to any hard, dark rock.

Places where the Great Whin Sill is exposed at the surface give us some of the most spectacular views in Teesdale. Heading south, these are Hadrian's Wall and the three famous waterfalls of the Cauldron Snout, High Force and Low Force.

The Roman Empire expanded to its greatest size under the leadership of Emperor Trajan, who ruled from 98 AD until his death in 117 AD and Northumberland marked its most northerly limit. In the Roman empire important centres were connected by roads to facilitate troop movements. Forts were spaced along the routes at about fourteen Roman miles apart (a normal one day march for armed troops). The forts varied in size from small, to provide overnight accommodation for troops on the move, to fortresses designed to accommodate large numbers of troops on a permanent basis. For defensive reasons, the empire's boundaries were marked by rivers, or where this was not possible, by fortified roads. The Romans penetrated well into southern Scotland but the original east-west boundary in Britain was to have been the rivers Forth and Clyde. For unknown reasons, this was abandoned in favour of a Tyne-Solway boundary and a road connecting the two great rivers with forts along its length.

Trajan died in 117 AD and was succeeded by his adopted son Hadrian. In 122 AD Hadrian improved the defensive boundary road by constructing the wall, from Wallsend-on-Tyne to Bowness-on-Solway, a distance of 73 miles, that now bears his name. Initially of turf, the wall was later converted to a stone wall. Evidence of several of the earlier forts can still be found.

Scholars disagree on the reason for building the wall. It is a common misconception that the wall was primarily a defensive measure against barbarian Scots. The east end of the wall is in England and, in Roman times, local traders passed both ways through the wall daily. It seems more likely that the wall served as a ‘customs’ facility, controlling movement in and out of Roman Britain. Defence of the boundary was improved by building the wall where the Great Whin Sill surfaces as a steep escarpment.

High Force and Low Force are two spectacular waterfalls where the river Tees flows over the exposed whin sill. ‘Force’ is the local term for a waterfall. By parking at the Bowlees visitor centre it is possible to take a pleasant riverside walk,on the Pennine Way, to link both falls.

At High Force the river Tees plunges 70 feet over the Whin Sill edge and is said to be the largest waterfall in England. The choice of adjective is important as there are greater falls of much less flow; for example, Kinder Downfall in the Peak District falls 30 metres but the flow rate is much lower. In high

Fig 1 High Force, Teesdale

Fig 2 Low Force, Teesdale

winds water can be blown back up the fall and high into the air as a fine spray that can be seen from several miles away and can be mistaken for smoke, - see page 22!

Low Force is less spectacular but is still beautiful. When we were there we were entertained by two young women and a young man taking it in turns to paddle canoes over the wider of the two falls. Rather them than me I thought – but they seemed quite competent and the two young women were able to rescue the young man when his first attempt (that we witnessed) was not too successful!

Further upstream the Tees flows into Cow Green reservoir, the output of which, called the Cauldron Snout, then tumbles down a rocky staircase of Whin Sill ledges over a distance of 200 yards earning it the name of ‘longest waterfall in England’.

Fig 3 The Cauldron Snout

Fig 4 Pennine Way, Cauldron Snout

It was somewhat alarming to see hikers with young children on their backs climbing and descending this rugged path so close to the steep edge of the fast moving torrent of water in the cataracts below

A reservoir was constructed at Cow Green moor between 1967 and 1971 to regulate the flow of water in the Tees and provide a constant supply of water to important industries further south. Construction of the dam was opposed by conservationists because of the rare plants that occurred only there. It was

Fig 5 Spring Gentian, *Gentiana verna*

primarily to look for these plants that prompted our visit to Cow Green Fortunately, only an estimated ten per cent of this critical reserve was destroyed.

We were a little early in the year for one rarity, the Teesdale violet, *Viola rupestris,* which flowers from May to July. However, we timed our visit perfectly for another extremely rare plant.

We were lucky to see and photograph the beautiful Spring Gentian, that seemed to be growing everywhere.

Spring Gentian, *Gentiana verna*, is an alpine flower that occurs only at this region in England – though it does occur at the Burren in Northern Ireland.

On the way to the reservoir outflow we saw evidence of former industrial activity; pieces of galena (lead sulphide), evidence of tramways used to carry the ore away and the fenced-off shaft of a former lead mine. The lead occurred as Galena in near vertical narrow veins that were worked downwards by local miners. The area was never a large source of lead, most mines being worked by only a few men.

Fig 6 Disused Lead Mine Shaft

Fig 7 'Sugar' Limestone

We also saw exposed patches of 'Sugar Limestone'. Sugar limestone is limited to just two localities nationwide. It occurs where igneous Dolerite intrusion of Carboniferous Limestone deposits bakes the limestone to a sugar-like marble that is frangible and highly rich in lime. This enriches the grassland, enabling calcicolous grassland species, like those mentioned above, to thrive.

The Pennine Way passes Cow Green reservoir then descends over large rocks beside this outflow from the dam, the Cauldron Snout,and continues southwards to High Force and Low Force. These three tourist attractions are located along a six-mile stretch of the river Tees. If you feel energetic and the weather is fine, the Pennine way is a good way to visit all three. They offer a great day out for those that love the countryside and fresh air, but do allow plenty of time to look around.

There is so much geology and natural history to see in this lovely part of the country that one holiday is not enough. But geology is not the only attraction of the area.

If you are also interested in history, then Barnard Castle is just a few miles to the south. Barnard Castle occupies a prominent position on a high rocky promontory overlooking a bend in the rock-strewn river Tees. Though the name is now associated with the town, the town took its name from the spectacular castle that it grew up around. Before the Norman conquest upper Teesdale was in the hands of the Earls of Northumberland. After murder of the Norman Bishop of Durham, William II decided to break up the Earldoms into smaller Baronies and gave the area around what is now Barnard Castle to the Balliol family. In the late 12th century, the earthwork fortifications were rebuilt in stone, by Bernard de Balliol from whom the castle and hence the town takes its name. The castle passed into the hands of Richard Neville, Earl of Warwick and eventually to Richard III who inherited it from his wife Anne Neville. After Richard's death at the battle of Bosworth Field in 1485 the castle fell into ruin. It is now maintained by English Heritage.

If your interest is more modern history you should not miss the opportunity to visit the unique Beamish, 'The Living Museum of the North' five miles south of Gateshead

After Beamish Colliery ceased operation the colliery space was used to create a 'living' museum depicting life in Northern England in the nineteenth and early twentieth century. A village was created with a main street, church, school, miner's cottages and farm. All features of the museum, except the colliery and Pockerly Old Hall, were rescued from elsewhere, being dismantled, imported to the colliery area and rebuilt. New features seem to be added continually. Finally, the site is circled by an operational road and tramway that transports visitors around the site, free of charge, in vintage buses and trams. The museum opened in February 1970 and celebrated forty successful years in 2010.

Some idea of the nature of Beamish may be gained from the pictures in the picture gallery below. This is not a static museum. All of the buildings are manned by appropriately dressed staff and it is possible to buy produce in the Post Office, Confectioners and Bakery.


Beamish Colliery


Barclays Bank

Jubilee Confectioners


Northern Daily Mail


Hardware Shop


Delivery Van in Main Street


Main Street from Memorial Garden


Pockerly Old Hall


A Nursery in Main Street


The Village School


Engine 'Locomotion'


Two Trams for free Transport!

References

Cow Green Reservoir: www.where2walk.co.uk/lake_district/cumbrian-pennines/cow-green-reservoir/

Beamish: http://www.beamish.org.uk/areas-of-beamish/

Rock or Mineral?

John Taylor

As a mineral collector, mostly surrounded by fossil collectors and a few geologists, I am often asked the question "What is the difference between a mineral and a rock?"

The answer I invariably give is "A rock is a mixture of minerals just as a Christmas pudding, a stew, or fruit salad, is a mixture of its ingredients.". The individual constituents in a pudding, salad or stew can be identified but the proportions vary from sample to sample. Moreover, we exercise our culinary skills by creating lots of different puddings, salads and stews by altering not only the actual ingredients but also their proportions. Every serving of a particular stew will be unique because it is impossible to count and control the number of specimens of each ingredient in a sample.

Did you know that Wikipedia (https://en.wikipedia.org/wiki/Stew) lists nearly 100 stews, from Baeckeof-fe, a potato stew from Alsace, to Yahni, a Greek Turkish and Persian stew. The list includes Bouillabaisse, a fish stew from Provence; Chili con carne, Mexican-American meat and chilli pepper stew; Goulash, a Hungarian meat stew with paprika; Irish stew, made with lamb or mutton, potato, onion and parsley;and Ratatouille, a French vegetable stew. A good chef would recognise and be able to prepare most of these just as a professional geologist will recognise the different rock types.

Geologists define three major classes of rock: Igneous, Sedimentary and Metamorphic.

Igneous rocks (from the Greek *ignis* for 'fire'), are rocks formed by cooling and solidification of molten rocks (magma). The original rock before melting could have been from any, or all, of the three main types. The constitution of an igneous rock is determined by the mix of rocks in the original melt. The combinations are theoretically infinite but geologists have drawn up categories to aid discussion of igneous rock types - particularly for their use!

Sedimentary rocks are those formed as sediment resulting from erosion of surface rock, mostly by wind and/or rain. The sediment is carried by wind or water to the sea where it is then deposited, mixed with the calcite remains of sea creatures and compressed to form a solid rock. Sedimentary rocks are classified by their depositional strata and the source of the strata sediments.

Metamorphic rocks (from the Greek words *meta*, meaning 'after' and *morph*, meaning shape) are rocks that have undergone change, mostly as a result of heat. Thus marble is limestone, mostly calcite or dolomite, that has been subjected to, and altered by, heat.

How and why is a mineral different?

A mineral is a chemical compound with a specific chemical formula.

By analysing compounds, chemists have shown that they consist of individual elements, that they have been able to isolate, and to identify their properties. They range from hydrogen the lightest to uranium the heaviest. Taking the weight of hydrogen as 'one unit', that they call its atomic weight, they have placed in order, by chemical reaction, the other elements as they have been identified and analysed,

Initially there were gaps but, over time, these were filled. It is now known that there are ninety two naturally occurring elements, thus uranium has the atomic number ninety two. Everything on our planet, living or inert, from bacteria and algae to whales and oak trees, from the finest grain of clay to huge mountains, consists only of these ninety two elements arranged in different configurations.

These elements combine to form compounds. Thus two atoms of hydrogen combine with one atom of oxygen to form hydrogen oxide, having the formula H_2O, that we call 'water'. Compounds can exist in more than one 'phase'. Water is normally a liquid but at temperatures below 0°C it exists as a solid, ice; above 100ºC it exists as a vapour, steam. Whatever its phase, its formula remains unchanged as H_2O.

A mineral is a chemical compound formed by combination of individual elements. Each mineral has a defined set of constituent elements arranged in a defined structure. Its physical properties can change but its chemical properties remain the same!

As a result, there are at present around 4,000 mineral types formally identified and listed in the '*International Encyclopedia of Minerals*' prepared by 72 internationally recognised mineralogists.

Samples of a given mineral may differ in form or colour according to how its constituent crystals grew but all will have the same basic molecular content and the same, verifiable, chemical formula.

Some minerals can exist in more than one form. These forms have different molecular structure but have the same type and number of atoms and the same chemical formula. Some atoms exist in more than one form, called allotropes. Probably the best known example is carbon, graphite and diamond, the three allotropes of carbon.. Differing dramatically in appearance and physical properties, they all have the same chemical formula, C, and the same chemical properties.

Why is this important?

Crystals grow as the chemical is deposited. Growth rate may change over long periods of time so that two specimens will almost certainly have a different appearance. Two mineral collectors may each have a specimen of, say, Fluorite, chemical formula CaF_2. One specimen may be a deep green, the other a beautiful purple; they may be of different size and crystal arrangement but both can be tested and verified to be chemically the same. One knows precisely what one is dealing with.

Scientists have been able to calculate the relative abundance of the ninety two naturally occurring elements and have shown that the ten most abundant elements account for 98.86% of all matter.

These elements and their abundance level are listed in table 1

Table 1. The Abundance of Elements

Oxygen, 47.4%	Sodium, 2.3%
Silicon, 27.7%	Magnesium, 2.3%
Aluminium, 8.2%	Potassium, 2.1%
Iron, 4.1%	Titanium, 0.56%
Calcium, 4.1%	Phosphorus, 0.1%

It will be seen that Oxygen and Silicon together account for 75.1% of all matter. If aluminium is added then Oxygen, Silicon and Aluminium together account for 83.3% of matter.

It will therefore come as no surprise that these three elements dominate in all minerals and therefore rocks. Most frequently, rock forming minerals are based on the $-SiO_4$ combination in which a silicon atom (having a valency of 4) connects to four oxygen atoms (valency of 2) to form a tetrahedron in which the four spare bonds of the oxygen atoms are taken up by other atoms (see Figure 1 right).

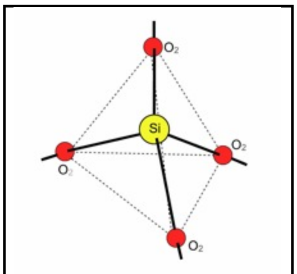


Fig 1 SiO_4 tetrahedron

The silicon tetrahedra also link together to form rings and chains that are the building blocks of most rock-forming silicate minerals. Figures 2 to 4 below show the basic building blocks of ring silicates, single and double chain silicates.

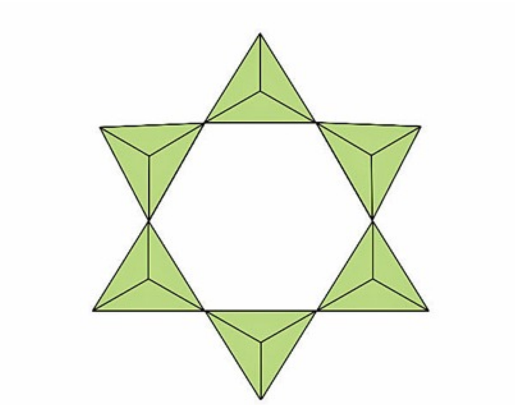


Figure 2 Ring Silicates

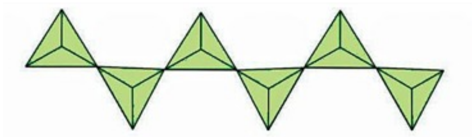


Figure 3 Single Chain Pyroxene Group

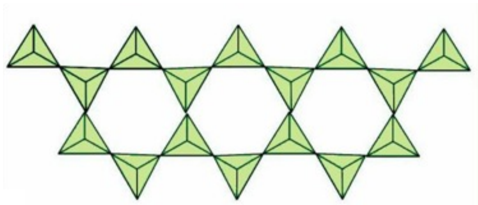


Figure 4 Double Chain Amphibole Group

A year or so ago I attended a meeting of the British Micromount Society and had the opportunity to collect a sample of igneous rock from Mendig, Laacher Lake Volcanic Complex, Eifel, Germany. It is shown in Figure 5. An enlarged view, taken through a microscope is shown in Figure 6, in which the crystals of minerals can be seen. A detailed analysis of this specimen was available and is shown in Table 2.

Fig 5. Igneous Rock from Eifel, Germany

Fig 6. Magnified view of specimen

Table 2

Aegirine, $NaFe^{3+}Si_2O_6$	Magnetite, $Fe^{2+}Fe_2{}^{3+}O_4$
Amphibole, $X_7Si_8O_{22}$	Quartz, SiO_2
Aragonite, $CaCO_3$	Pyroxene, $XY(Si,Al)_2O_6$
Biotite Mica	Rutile, TiO_2
Fluorite, CaF_2	Saniden, $(K,Na)AlSi_3O_8$
Gypsum, $CaSO_4.2H_2O$	Titanite, $CaTiOSiO_4$
Hauyne, $Na_6Ca_2Al_6Si_6O_{24}(SO_4)_2$	Zircon, $ZrSiO_4$
Magnesite, $MgCO_3$	
Analysis of mineral content of Mendig rock specimen of Figs 5 and 6	

The minerals shown in black in table 2 are common rock forming minerals.

Biotite Mica is one of a group of silicate minerals in which SiO_4 tetrahedra are linked to form sheets with weak bonds between the sheets that give the Mica minerals their characteristic cleavage property.

Pyroxenes are an important group of ferromagnesian silicate minerals that are a major constituent of almost all igneous rocks. The SiO_4 tetrahedra are linked at two corners to form an infinite single chain (Figure 3). The spare ionic bonds are are principally Iron and Magnesium.

Amphiboles are a common component of most igneous and metamorphic rocks. They differ from Pyroxenes in that the SiO_4 tetrahedra are linked as a double chain (Figure 4). The remaining links are either hydroxyl (OH) or halogen (F,Cl) ions.

There is another major group of silicates that is dominant in rocks, accounting for about 60% of the earth's crust; these are the Feldspars. There are three major minerals in the feldspar group, these are:- Potassium Feldspar, $KAlSi_3O_8$, Albite, $NaAlSi_3O_8$ and Anorthite, $CaAl_2Si_2O_8$. A 'solid solution' exists between Potassium Feldspar and Albite called the Alkali Feldspars. A similar 'solid solution' exists between Albite and Anorthite called the Plagioclase Feldspars. A common plagioclase mineral that features in many mineral collections is Labradorite having between 50% and 70% Anorthite.

We have now defined the structures of the major rock-forming minerals, the silicates, that account for more than 83% of rocks. We are in a position to allocate mineral types to recognised geological groups as shown below:-

Table 3 Major Rock-Forming Mineral Groups

- **Ring Silicates:-**
  - ❑Olivine, Garnet, Epidote, Tourmaline groups
- **Chain Silicates**
  - ❑Pyroxene group (single chain),
  - ❑Amphibole group (double chain)
- **Sheet Silicates**
  - ❑Mica group
- **Frame Silicates**
  - ❑Feldspar group,
  - ❑Zeolite group
- **Non-Silicate Minerals**
  - ❑Oxides, Sulphides, Carbonates, Nitrates, Phosphates, Sulphates, etc.

Hopefully, we have established a link between rock classifications and the mineral types they include but we now have more than four thousand ingredients for our geological 'Christmas Pudding'.

There has to be some way non-specialists can classify rock types and there is a simple summary for igneous rock types based on the percentage of silica as shown below in Table 3.

Table 3

Grain Size	Igneous Rock Types by Percentage of Silica			
	Acid Igneous >66%	Intermediate Igneous 52% - 66%	Basic Igneous 45% - 52%	Ultra Basic Igneous <45%
Coarse	**Granite**	**Diorite**	**Gabbro**	**Peridotite**
Medium	**Micro-Granite**	**Micro-Diorite**	**Dolorite**	**See note 1.**
Fine	**Rhyolite**	**Andesite**	**Basalt**	**See note 1**

Note 1: Peridotite forms most of the earth's mantle but forms only a small proportion of the crust. The Peridotite, mostly Olivine and plagioclase feldspar, rises to the surface as pipes and erodes rapidly. These pipes are the principal sources of diamond (in Kimberlite) and chromium.

However, mineral collectors do not often collect rocks! Though the minerals in the Mendig rock specimen can be clearly seen in figure 6 they would not be likely to attract the attention of a mineral collector. This is because the principal attraction of minerals is the beauty of their crystal form (perfectly formed crystals with sharp edges and smooth crystal faces), the arrangement of fine groups of crystals and their colour. Many mineral collectors aim for a systematic collection, for example Fluorites, while others have a much wider range of specimens. However, for all, the primary interest is most likely to be aesthetic. The minerals in Figure 6 are hardly attractive, they show fractures, not crystal faces, and look like what they are, the cooked ingredients of a 'geological stew'.

If you wish to take a more scientific approach to mineralogy (the science of minerals) then crystals can be defined by seven mineral systems, each of which has a number of classes. These are:-

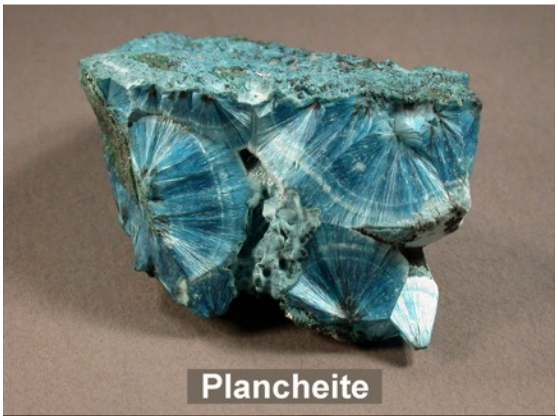
Triclinic (2), Monoclinic (3), Orthorhombic (3), Trigonal (5), Hexagonal (7), Tetragonal (7), Isometric (5), giving a total of 32 crystal classes, but does one need to know this?

Oliver Heavyside, an English self-taught mathematician, physicist and engineer, invented an algebraic technique for solving differential equations that was very effective in the field of electrical engineering. It was later shown to be identical to the more rigorous mathematical transform of French philosopher Pierre-Henri Laplace. When Heaviside was criticised for using 'doubtful techniques' (that never-the-less gave the right answers!) he is reported to have replied "should I refuse to eat my meals because I do not understand the fundamentals of digestion?"

In other words, minerals are there to enjoy. The enjoyment is there for all who can see, one does not have to be a mineralogist, chemist or geologist, merely to have an eye for beauty!

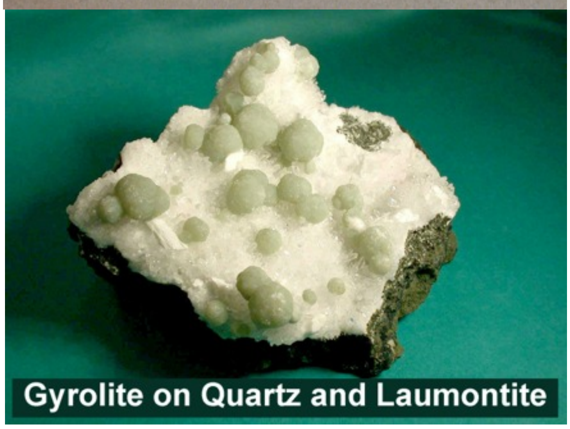
To encourage your interest here are a few mineral pictures that hopefully will appeal to you:-


Topaz


Plancheite


Kyanite


Kutnohorite


Gyrolite on Quartz and Laumontite


Rhodochrosite

Anne Padfield

Geology of Kent

In Kent there's the Gault
And the Folkestone Fault
And the Chalk of the North Downs escarpment.
There's the clay in the Weald,
After Atherfield,
And Ragstone in many a battlement.

At Sheppey there's clay,
Same as London way,
Which slips down the cliff in rotation.
At Thanet there's sand,
Just a narrow band,
Not the type at the beach for vacation.

On top of a hill
Is a Clay-with-Flints fill,
Obscuring a dissolution feature.
A layer of Head,
A thin Loess bed,
Covers up a chalk ammonite creature.

Gulls in the Greensand,
Flints found in a band,
The Medway Terraces yielding their gravel.
Nailbourne deposits,
The old river silts
And pyrite and selenite minerals.

A sharks tooth or bone,
A sea-urchin cone,
The Pilgrims Way routed on Melbourne Rock.
Folkestone to Dover,
Dips North all over,
The older beds under at Dover's dock.

From Sandgate to Hythe,
Greensand takes a dive,
And is exposed as a bed of old Rag.
With coal down below
And groundwater flow,
The geology of Kent's a mixed bag.

Anne Padfield

Britain's Waterfalls and Karst Geology

John Taylor

In the article "A Teesdale Holiday" I described High Force in Teesdale, which has a free fall of 70 feet, as quote "..the largest waterfall in England. The choice of adjective is important as there are greater drops of much less flow…".

When describing waterfalls, one has to be careful in choice of adjective because people have a distinct preference for their own local waterfall. The wording of claims has to be carefully chosen to emphasise superiority while still being accurate!

Other serious contenders for 'the most notable waterfall' in England are Kinder Downfall in Derbyshire and Hardraw Force in North Yorkshire. They all occur in regions of elevated limestone platforms.


Figure 1 Kinder Downfall

Kinder Downfall occurs where the river Kinder plunges 100 feet from the peat-covered plateau of Kinder Scout to the valley below, just north of the village of Edale in Derbyshire. Though a greater drop than High Force the flow is considerably less even at flood level. It often freezes solid in winter when it becomes a challenge for rock climbers to scale its icy surface. Facing west, the fall often experiences a strong westerly wind that blows up the valley and carries the water back up to the top of the plateau and high into the air as spray so fine that, seen from a distance, it looks like smoke. The brilliant picture on the right shows Kinder Downfall losing the battle against a strong wind!

It was down-loaded from Wikipedia and is reproduced with the following acknowledgement:-

When I was following the original route of the Pennine Way across Kinder Scout to Kinder Downfall, it was this spray carried high into the air, that prompted my comment about the danger of lighting fires in the peat The peat on the top of this plateau is many feet thick but has been eroded by both water and walkers to form deep groughs that have to be traversed. This can make navigation tricky. Setting a compass bearing, one can then aim for a particular feature on the horizon only to find that, after descending into a grough then climbing out on the far side, the aiming point is no longer visible! The Pennine way across Kinder was rerouted to avoid further deterioration of this rare environment.

The free-fall height of Hardraw Force is also claimed to be 100 feet, some 30 feet higher than High Force, but the flow rate is significantly less; it is also in a private valley and an entrance fee is charged.

There is, however, one fall that completely over-shadows the above falls yet is seen by very few people.

At over 700 metres, Ingleborugh is the second highest mountain in the Yorkshire Dales. Fell Beck, a stream on the lower slopes of Ingleborough, terminates abruptly at Gaping Ghyll, the famous pothole, where it plunges 340 feet into the limestone to form Britain's highest and most spectacular waterfall. At the base of the open hole or Main Shaft, the action of water on faults in the rock has carved out a huge cavern. The cavern has been measured using range-finding radar and is said to be large enough to hold St Paul's Cathedral. The actual cavern is even larger than it appears because the rock floor is much lower, the cavern being partially filled with strewn rocks and smaller debris that has accumulated in the cavern over time. Though a potholers' delight few ordinary people have seen Gaping Ghyll because most entrances are pot holes where one has to squirm through narrow muddy passages.

In May 1983 potholers, working often through flooded passages and clearing blockages, managed to establish a connection between Gaping Ghyll and Ingleborough Cave thus defining the route of flood water from Fell Beck to Ingleborough Cave. Twice a year, at the end of May and the end of August, the Bradford Pothole Club and Craven Pothole Club open Gaping Ghyll to the general public by setting up a winch facility to lower people, one at a time, to the cavern floor in a chair at the end of a steel cable. The trip costs £15 (that includes the return journey) and the descent takes about one minute!

Karst Geology is the name given to a landscape, sometimes a hidden world of underground streams and caverns, that is caused by acidic rainwater gradually dissolving limestone rock; typically calcium carbonate or dolemite (calcium, magnesium carbonate). Karst geology is a prominent feature of much of northern England from Derbyshire to the Scottish border. One does not have to go underground to see it. Famous waterfalls such as those mentioned above, Aysgarth and Richmond were shaped by the action of flowing water, as were popular tourist attractions such as Malham Cove and the "Buttertubs" in Swaledale.

Malham Cove is an elevated limestone pavement characterised by raised areas called 'clints' bordered by ditches called 'grikes' The limestone was deposited at the bottom of a sea, near the equator, in the Carboniferous period 350 million years ago. It was subsequently uplifted and covered by dense forest. During the last ice age the area was covered by glacial ice up to a kilometre thick. As the ice age receded, the ice melted and flowed downhill under the action of gravity carrying away the soil and vegetation to expose the limestone surface below. The grikes are joints in the limestone, vertical to the bedding planes, that have been eroded by acidic water dissolving the carbonate limestone. Limestone pavements can be seen all over the world and are found all over northern England and Scotland, but Malham is special. At one time it was probably a giant waterfall. There is still a small stream flowing away from the cove and the last remnant of a fall can still be seen.

The 'Buttertubs' is another karstic feature that attracts visitors to the Yorkshire Dales. The attraction is located at the western end of Swaledale two kilometres west of Muker and north of a minor road just off the B6270 at a left fork. It is a pothole, twenty metres deep filled with vertical columns of limestone rock that have been slowly etched away by acidic water draining into the hole. It is said that the name derives from the practice of dairy farmers lowering tubs of butter into the hole to keep them cool in hot weather as they rested on their way to market. The large cities such a Durham, York and Barnard Castle are always popular with tourists for their history and beautiful cathedrals and castles. But for those who enjoy open spaces and stunning scenery,the fascinating geology of the area has lots to offer.

Fig 2 The Buttertubs

Fig 3 Sink Hole at Arncliffe

Fig 4 Malham Cove

Fig 5 Limestone Pavement

For further information, here are some interesting references:-

http://www.bpc-cave.org.uk/gaping_gill_setup.htm

http://www.limestone-pavements.org.uk/geology.html

http://www.hardrawforce.com/waterfall.html

What's in a Name?

John Taylor

In reading about geology or mineralogy have you ever wondered how the peculiar names were derived? After all, they don't seem to be much related to words we use in our everyday lives. Who, for example, named the Palaeozoic, Mesozoic, Cambrian and Silurian periods? What do these names mean and how were they chosen? Why is the beautiful blue Lead Phosphate mineral called Plumbogummite?

Part of the answer to these puzzles lies in 'The Education Act 1944', introduced by the Conservative Minister R. A. Butler. This introduced for the first time three 'streams' of free schooling for all children between the ages of five and fifteen, secondary modern, technical and grammar. Prior to that, apart from a few scholarships, the best schooling was mostly only available to those who could afford to pay for it. The education those privileged ones received dated back hundreds of years and was based on the Classics, the study of the history and language of the ancient Roman and Greek civilizations. It would in most respects have been familiar to Shakespeare. In the reorganised, available to all, education it was mostly only grammar schools that had staff available to teach Latin (which was not obligatory - unless one wanted to get into Oxford or Cambridge) and very few of these schools had staff able to teach Greek. In the greatly expanded education system there was simply not enough qualified teachers of these classics subjects to go round. Why is this relevant?

In 1543 Nicolaus Copernicus, a Prussian who would have had Polish as his native language, published a paper "*On the revolutions of the Heavenly Spheres"* putting forward for the first time the theory that the sun, not the earth, was the centre of our solar system. It was actually published in Latin as "*De revolutionibus orbium coelestium*". You can see the similarity to English because many of the words we use today have their origins in Latin.

In July 1687, Isaac Newton published "*Philosophiæ Naturalis Principia Mathematica"* in Latin or, as we would put it in English, "*Mathematical Principles of Natural Philosophy*".

In the past Latin and Greek were the common languages of communication between learned people of different nationalities. Until recent developments, where new minerals have been named in honour of people, minerals were given descriptive names having origins in Latin or Greek. The common name of Copper Aluminium Sulphate (formula $Cu_4Al_2(SO_4)(OH)_{12}.2H_2O$) is "Cyanotrichite". In Greek this means "cyan (blue) trichos (hairs)". 'Blue hairs' at least tells me something about the mineral, if only its appearance. A name 'bertsmithite' tells me nothing (even if I know something about Bert Smith himself!).

I am not suggesting that we should all learn Latin and Greek - it really is not necessary. However, several terms and prefixes, having their origin in the classics, are encountered frequently in geology. If learned, these can give us some useful preliminary information before we delve deeper to learn more.

Returning to my original question, Palaeozoic means 'old life' and Mesozoic means 'middle life' if one knows that palaeos (Greek παλαιός) means 'old; mesos (Greek μεσοζ) means 'middle' and zoe (Greek ζωή) means 'life'. They were natural choices of name for geologists with a classics education.

According to legend Brutus, the first King of Britain (before the Romans), gave all of the land west of the river Severn to his third son Camber to rule and named the area, that we now call Wales, Cambria in his honour. With a classics education Adam Sedgwick would probably have known this.

The Cambrian Period was so named by Adam Sedgwick because he knew that 'Cambria' was the Latin name for Wales where he had studied these ancient rocks and where they are best preserved and studied. Encouraged by his friend Adam Sedgwick, Sir Roderick Murchison named the Silurian period after the Silures, a Celtic tribe living in south-east Wales. Similarly, the Ordovices were a Celtic tribe living in north–east Wales. What could be more natural than to name a geological period after an ancient tribe living in the area where the rock formations were first studied? The classics education of these two great geologists was again being used in their work.

Wikipedia, the on-line encyclopedia, is a wonderful source of information if you want to learn about a particular subject matter but don't have a suitable book. It frequently contains an etymology section explaining the origin of the data presented. By looking up details on any geological subject you want to know more about, you could become quite familiar with terms that have their origin in the classics.

To get you started the following table lists some frequently occurring prefixes from Latin and Greek (with their origins). It is hoped that you may find it useful in your geology studies.

Some Latin and Greek Terms Used in Geology

Prefix	Meaning	Derivation	Example
A, an	not	[G], a	Anhydrite = (mineral) without water
Alb, albus	white	[L], albus	Albite = white (because of its colour)
Aqua	water	[L], aqua	See 'mare' below
Argent	silver	[L], argentum	Argentopyrite = silver-bearing pyrite
Bar	heavy	[G], baros	Barite = very dense mineral
Carn	flesh	[L], carnis	Carnelian = flesh coloured stone
Chalco	copper	[G], chalcos	Chalcocite = copper sulphide, Cu_2S
Chlor	green	[G], chloros	Chlorapatite = $Ca_5(PO_4)_3Cl$, for its green colour
Chryso	gold	[G], chrysos	Chrysoberyl = for its gold colour
Clase	fracture	[G], clase	Orthoclase = has a straight fracture
Clino	slope	[G], klino	Clinoclase = $Cu_3(AsO_4)(OH)_3$, oblique cleavage
Cryo	ice	[G], crysto	Cryolite, = (Na_3AlF_6), for its icy appearance
Crypto	hidden	[G], krimeno	Cryptocrystaline = having microscopic crystals
Cupro	copper	[L], cuprum	Cuprostilbite = Copper antimonide, Cu_2Sb
Cyano	blue	[G], cyan	Cyanotrichite = $Cu_4Al_2(SO_4)(OH)_{12}.2H_2O$
Epi	additional	[G], epidosis	Epidote = one prism side is longer
Eryth	red	[G], erythros	Erythrite = cobalt arsenate (refers to its colour)
Gen	birth	[G], gennisi	Orogeny = birth of mountains
Glauco	bluish green	[G], glaucos	Glauconite = a component of 'greensands'
-gon	corner	[G], gonia	Hexagon = having six (hexa) corner angles
Hema	blood red	[G], aema	Hematite = Iron Oxide
Hemi	half	[G], hemi	Hemisphere = half sphere e.g. earth region
Hexa	six	[G], exi	See '-gon' above
Hydro	water	[G], hydro	Hydrogen = water forming (birth - by oxidisation)
Iso	equal	[G], isos	Isomers = having the same chemical formula
Leuco	white	[G], leucos	Leucocytes = white blood cells
Lith	rocky, stone	[G], lithos	Lithosphere = stone sphere (Earth's crust)
-logy	study of	[G], logia	Geology = study of the earth
Mare	sea	[L], mare	Aquamarine = seawater (refers to its colour)
Melano	black	[G], melanos	Melanite = a black form of Andradite garnet
Meso	middle	[G], mesos	Mesozoic = middle life
Morph	shape	[G], morphe	See 'pseudo' below
Oro	mountain	[G], oros	Aurichalcite = mountain copper
Ortho	straight	[G], ortho	Orthoclase = straight fracture
Palaeo	old	[G], palaeos	Palaeozoic = old life
Phyllum	leaf	[L], phyllum	Phyllotungstite = reflects crystal habit
Plumb	lead	[L], plumbum	Plumboferrite = lead, manganese, iron oxide
Pseudo	not true	[G], pseudo	Pseudomorph = a mineral replacing another
Pyr, pyro	fire	[G], pyros	Pyrite = produces sparks when struck
Rhodo	rose	[G], rodon	Rhodochrosite = $MnCO_3$, Manganese carbonate
Xantho	yellow	[G], xanthos	Xanthoconite = Ag_3AsS_3 has yellow streak
Xen	stranger	[G], xenon	Pyroxene= stranger to fire
Zo	life	[G], zoe	Zoology = study of life,

Indoor Meetings Programme, 2016

Ann Barrett

We meet at 7.00pm on the third Tuesday of each month in the United Reformed Church. 67 Week St, Maidstone, Kent, ME14 1QU

Please bring any material to Indoor Meetings: this does not have to be tied in to the subject of the day and could include recent finds, specimens for identification and books, maps, photographs, etc. of general interest. Details of forthcoming field trips will be given out at Indoor Meetings. There is an admission charge of £1 per meeting (£3 per meeting for non-members). Non-members and guests are always welcome and are admitted free of charge for one meeting. Thereafter they will be charged the appropriate entrance fee. Refreshments are 20p.

Indoor Programme Secretary: Ms. Ann Barrett.

Tel. 01233 623126, e-mail annbarrettgeo@gmail.com

19th January 2016	**Tony Mitchell.** The Silk Road, Part 2
16th February 2016	**Yvonne Cutt** Hawaiian volcanics and how they have affected the fauna and flora.
15th March 2016	**Annual General Meeting** **James Downer** Achanarras Quarry, Caithness.
19th April 2016	**Geoff Downer** The Building Stones of Maidstone
17th May 2016	**Nicola Coffin and Sam Patterson** Culand Pits Specimens on display from the Nick Baker Collection.
21st June 2016	**Dr Chris Duffin** Tyranosaurus Rex
19th July 2016	**David Bowler** What really is fracking and would it be safe here in the Weald?
16th August 2016	**Anthony Brook and Roger Cordiner** Majorca
20th September 2016	**Dr Anne Padfield** Magnificent minerals in thin section
18th October 2016	**Dr Geoff Turner** Treasure from the North Yorkshire Coast
15th November 2016	**Alison Taylor** The Faroe Islands
20th December 2016	**Christmas Evening [3rd Week]** Please bring labelled fossils, minerals and rocks for sale for the benefit of the Group and any other specimens found during the year for display. Members may also care to bring in refreshments

Professor Dr Edmund A. Jarzembowski, 'Dr Ed'

Tony Mitchell

I think I first came across Ed during one of the GA field trips that he organised to the Weald of Kent, especially to Smokejacks and the little known Auclaye pit. At the time he was working at the Booth Museum in Brighton. My first real contact was there when I brought some Insects from Auclaye for him to look at. Later he sent me a proof of a GA article including my finds. It included the statement that I had found the hard layer by 'probing with a mental rod' [It became 'metal' in the article].

When the value of coal rose, a company in Somerset started extracting coal from the waste tip at Writhlington using some sort of sieve that produced a quantity of large lumps of rock. Ed joined some botanists looking for fossil leaves and asked if they had found insects. They said no, so he promptly found one. The Writhlington mine was already known for a giant 'dragonfly' found there. Ed persuaded the GA to buy the pile of several thousand tons of waste rock to be set aside as a geological nature reserve. He organised several field trips there and hundreds of fossil insects were found, as well as a few spiders. There can be few quarries in the area that he has not visited and collected fossils, especially insects. He was also instrumental in creating a rock store at the Butterly pit that exploits a different clay level from Smokejacks in the Weald.

After Ed obtained his post in charge of Natural History at Maidstone Museum he decided not to move house from the South Downs, as his wife Biddy was very happy in her job at the university, instead commuting to Maidstone. Later he found temporary lodgings and then lived with Betty and me for two days a week for the next 13 years.

He soon became well known at Maidstone, appearing frequently on South Eastern Television and the radio whenever any natural history subject was in the news. Although he was not keen on dinosaurs, that did not stop him enthusing publicly about them. I suppose it was this geological evangelical streak that got him involved in the creation of the Kent Geologists Group, meeting at first at the museum and then in various other locations. He was always ready to give a talk on almost any geological subject and to help in organising field trips.

On one trip to Thorness Bay on the Isle of Wight that he organised with the GA, we discovered a rich seam of fossil insect-containing rock which the group set to work to demolish. Some members of the group found as many as 100 specimens. Ed found very little himself, as his time was spent identifying other people's finds and recording them. At the end he persuaded everyone to collect all the waste into the canvas coffee sample bags he always used and I brought them home in my car to split over the next few years. Over 7000 fossil insect specimens are now housed at Maidstone Museum. With such a valuable resource, Ed soon had scientists from Poland, Germany and Russia coming to look at the collection and many new species were described.

Quite soon, he had me volunteering at the museum. He had involved Edna Clifford in creating a card index file of all the newly described fossil insects in the world. This now ran to over 1000 cards for species and more for the families and sites. I had just been looking at the Access database system and took over Edna's work extending it to include more fields, including synonyms. Ed continued writing papers and supplying me with foreign ones. It was useful that he could read Russian. [The database now has 27000 species recorded and is on the web].

Ed soon had a problem. A plan had been mooted to revamp the stores with more up to date units which should greatly increase the storage space. To help fill it up they also decided to close Chillington House next door, which housed much of the Museum administration staff and several rooms full of specimens. Ed's volunteers were now involved in cataloguing the collection for the first time on computer before everything was put into an outside store for almost two years. Access was the only choice, the alternative being Excel. Thanks to Ed, by the time it was necessary to pack everything into store, the Natural History collection was almost completely catalogued, unlike the rest of the collection. The databases included which box each specimen was housed in so everything could easily be found.

Ed now moved to China where he had access to even more exciting fossil insects being unearthed in superb condition. He still has contact with his volunteers in Kent, especially Fred Clouter, who has the task of turning Ed's pictures of fossil insects into ones that can be published. Ed has recently been awarded the 2015 Jiangsu Friendship Award for his work on Sino-British fossil insect cooperation.

Editor's Note

For those members who have not heard about the Award given to Ed Jarzembowski for his work in China I enclose below information kindly provided by Peter Austen:-

Ed Jarzembowski - 2015 Jiangsu Friendship Award

Congratulations to Ed Jarzembowski, who has received a Friendship Award from the Jiangsu Province of China (which has a larger population than the whole of the UK). The "Jiangsu Friendship Award" is the highest award of Jiangsu Provincial People's Government for foreign experts, and is given in recognition of outstanding contributions to Jiangsu Province with regard to economic progress and social development. The award was presented to Ed by the Provincial People's Government at a ceremony in September. Ed has been Visiting Professor at the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Jiangsu, since 2012, where his research into fossil insects has led to the publication of many papers with colleagues at the Institute. He has studied and undertaken fieldwork on mainly British fossil insects since the 1970s, and his work at Nanjing has allowed him to explore the links between the English Wealden and exceptionally preserved, Lower Cretaceous Chinese fossil insect faunas. The provincial government in Liaoning has recently helped found a new palaeontological museum there, and a new amber inclusions museum is anticipated along the Yangtze.

Peter Austen

Wealden News

Field Programme, 2016

We have no Field Meetings Secretary at present, a Volunteer is needed!

The Rock and Gem Shows at Kempton Park are two-day events.

The shows run from 10.00am to 5.00pm on Saturday and 10.00am to 4.30pm on Sunday.

The KGG is allocated three or four tables free of charge by the show organisers because we are considered to be an educational charity.

The activities provided consist of four microscopes for making microfossil and mineral slides; two seed mounting activities more suitable for younger visitors, two mineral/fossil identification-by-feel activities and sales tables that have to be manned. This can be an onerous task for just two people to support all day! Adrian Rundle and Dennis Fullwood transport the material from Adrian's home, set up the tables, then dismount them at the end of the weekend. Adrian Rundle provides all of the materials at his own expense and the voluntary donations made by the public all go to KGG funds.

Some support from KGG members to help and give Adrian and Dennis an occasional break would be much appreciated and it does not need any skill or need to be a regular commitment. There will be slack periods when you will have plenty of opportunity to look round the rest of the show

If you are willing to help please contact Chairperson, Anne Padfield

5th / 6th March 2016	**Rock and Gem Show, Kempton Park.**
4th / 5th June 2016	**Rock and Gem Show, Kempton Park.**
6th / 7th August 2016	**Rock and Gem Show, Kempton Park.**
12th / 13th November 2016	**Rock and Gem Show, Kempton Park.**