Issue 3
July 2017

The Silurian

The Magazine of the Mid Wales Geology Club

Contents

The Magazine of the Mid Wales Geology Club
www.midwalesgeology.org.uk

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This year the club has been in existence for 20 years, having been set up by Bill and the late Jim Nichols. To celebrate we held a day of talks and demonstrations accompanied by good food. Thanks to all those members who made the day what it was.

In this edition of the magazine we range broadly from the life of the Reverend John Edward Vize of Forden, through Offa and his dyke, artificial diamonds, to bricks.

Michele Becker

June 10th, the Club's 20th anniversary.

Submissions

Please read this before sending in an article.

Submissions for the next issue by the beginning of November 2017 please.

Please send articles for the magazine digitally as either plain text (.txt) or generic Word format (.doc), and keep formatting to a minimum. **Do not include photographs or illustrations in the document.** These should be sent as separate files saved as uncompressed JPEG files and sized to a **minimum size of 1200 pixels** on the long side. List captions for the photographs at the end of the text, or in a separate file.

'Members Photographs' and cover photos are also wanted. Cover photos need to be in 'portrait' format and a minimum of 3000X2000 pixels.

John Edward Vize
Anglican Vicar of Forden 1869 to 1910 and leading Mycologist.

Rev. John Edward Vize.

In the previous issue of the *Silurian* I wrote about the aspiring geologist Joseph Bickerton Morgan who lived for much of his short life in the Welshpool area. Although coming from a poor background and suffering from numerous setbacks he was able to achieve his aim of becoming a geologist, and in doing so was able to make a valuable contribution to our knowledge of geology. Whilst working as an honorary curator at the Powisland Museum he almost certainly came into contact with the Rev. John Vize who had donated a large collection of shells to the museum. It is known that Morgan classified and curated the collection.

On the face of it, Vize came from a very different mould, appearing at first glance to be the quintessential Victorian country parson, whose pastoral duties were sufficiently light to give him time to pursue his private interests in the antiquarian field and that of natural history. To many, his was a life of privilege but, like Morgan, he had known tragedy and uncertainty.

John Edward Vize was born in St. Mary-le-bow, London, in 1831. His father was a bookseller but business was not good and he soon returned to his previous profession of teaching. He had a sister, Lucy, and a brother William. A fourth child, Charles was born in 1837 but died when only a few days old, immediately followed by the children's mother who had been suffering from tuberculosis. A further blow came in 1840 when their father died, also of tuberculosis, leaving the children orphaned. Following these events the children came under the care of an aunt in Warwickshire and an uncle in London. They were provided with a good education, funded by a legacy from John's grandmother who had inherited money from the family brewing business in Rotherhithe.

In 1854, at the age of twenty three we find John, although as yet unqualified, serving as a curate in Bath. Here he met Hannah Louisa Ashley who, although thirteen years his senior, was to become his wife. He then enrolled at Trinity College, Dublin, where he completed a Bachelor of Divinity degree, after which he was appointed to the parish of Bray in County Wicklow. John and Hannah had four children, but only two survived into adulthood. John returned to England where he completed a Master of Divinity degree at Oxford in 1863. After holding appointments near Bath, he became Vicar of Forden in 1867 where he remained until his retirement in 1910.

Forden Parish Church, Montgomeryshire. Restored 1867.

John set about his duties in Forden. He was appointed chaplain to the Forden Union Workhouse and as chaplain he would also have served as one of the Board of Guardians. The records show that he worked hard to make improvements to the institution, where disease was taking a heavy toll on the residents. Such establishments were not always run in a humane way and Vize sought to bring enlightenment to what was, for the people forced to be there, a degrading and intolerable situation.

In the running of the workhouse we see in action the social responsibility of the church being discharged, although it is fair to say that not all Anglican clergy were as diligent as the vicar of Forden. But the vicar had other interests outside of the church. He was a gentleman scientist, avidly investigating the natural world around him. In our lifetimes we have seen the most amazing developments in the world of science with discoveries far beyond our imagination and the invention of machines and equipment able to facilitate and enhance the search for knowledge. The Victorians did not have such luxuries at their disposal. It is difficult for us to realise that virtually all the discoveries and knowledge about the natural world of geology, botany and zoology at that time were made by people like John Vize, working on their own, far from libraries or the world of instant information we have on the internet. They were all amateurs with hand lenses or, if they were lucky, a microscope. However, they laid the foundations of much of our knowledge of the natural history of Britain.

The ideals of these early naturalists were well summed up by D. E. Allen, who wrote *"Their years of peering closely, training the eye in the admiring of minutiae, the intricate details, the lowly magnificence of creation and in particular with their microscopes, the Victorians found a means of penetrating natures' furthermost recesses, of laying bare new aspects of the elemental."* Arguably, their diligence has never been surpassed, collecting, recording and preserving the living things which they searched for in the countryside. John Vize was a member of both the Woolhope and Powisland Societies, both typical of the learned and antiquarian societies which burgeoned in the second half of the nineteenth century.

J.E. Vize. Slide box containing 15 labelled glass slides, used to send out specimens.

Vize was interested in a wide variety of lifeforms but his passion was fungi. Modern re-assessment of his work suggests that he was ahead of the game in his understanding of the importance of fungi in the natural world. It was as recent as 1991 that Edward O. Wilson coined the word bio-diversity to encompass the variety of living things within an eco-system. He wrote *"Life is more diverse and more plentiful than anyone had previously known."* It is now appreciated that fungi, especially microscopic fungi, are known to constitute a much larger component of the bio-diversity of the earth that was thought possible in the time of Vize. They now compete with insects to be the most prolific of living things. There are six times as many fungi species known on earth as there are flowering plants, with many new species being discovered.

The pioneering work carried out by Vize has come to be very significant. Much of his work has survived and there is a large archive to be found. He was a meticulous worker. The microscopic fungi in which he was particularly interested can only be identified with certainty using a modern compound microscope. He was ahead of his time in realising that the careful storage of dried specimens was the only way in which the existence of a particular fungi could be proved and accepted in the scientific world. If necessary, they can be compared with other related specimens and newly discovered species, as well as used for further research.

As a mycologist, John Vize was almost entirely alone in Wales but there was one earlier mycologist of note. This was the Rev. Hugh Davies (1739 – 1821). Like Vize he was a clergyman, living on Anglesey. In 1813 he listed 336 fungi to be found on the island, quite an achievement at the time. He was something of a Welsh patriot, interested in the Welsh language and culture. However, perhaps because of this, he did not become widely known in the world of biology. Vize worked in relative isolation and so he was able to concentrate more fully on his work. However, he would have been aware of the huge advances in scientific thought which were being made at the time and it is worth noting that some of his contemporaries were changing our understanding of the living world for ever, principally Darwin (1809-1882), Wallace (1823-1913), Pasteur ((1820-1895) and Koch ((1843-1910). The extent to which Vize was aware of the importance of their work is unclear. We know that he was aware of, and greatly influenced by the Rev. M.J. Berkeley, often regarded as the Father of British mycology. Berkeley, like Darwin, had been guided in an interest in the natural world by J.S. Henslow, geologist and Professor of Botany at Cambridge. In 1846 Berkeley was able to show that the cause of potato blight was a fungus, thus establishing the true nature of infectious diseases in living things generally. From this Vize developed an interest in 'water fungus', a group which includes Downy Mildew.

Vize was a very careful observer of detail. For his time, he was technically very skilled in preparing permanent preparations of many microscopic fungi using glass slides, as well as pocketing and drying specimens for cabinet storage. It was common practice in the nineteenth century to sell collections of specimens, be they shells, plants, animal skins or geological samples. Vize was probably doing this to supplement his stipend and further finance his research. The boxes shown above are of the type used to send material to museums and educational establishments. Printed lists of numbered specimens would accompany the consignment. Vizes' collection numbers are still quoted in scientific papers today. It is pleasing that much of his work has survived. There is a complete set of specimens produced in this way in the *Herbarium* at Kew. There is another set of his specimens in Bolton Museum and another set of labelled specimens was held by Chester College. Many of these slides are still in perfect condition today, including pieces of named ferns and mosses, reflecting the wide range of his interests.

A selection of slides by J.E. Vize. A great variety of specimens were mounted.

Today we are used to the notion of the infectious disease and it is difficult to imagine that when Berkeley published his work on potato blight this was not understood. Vize makes reference to the deaths of children in his parish caused by diphtheria, in Victorian times the largest single cause of child mortality. Another common cause of death among his parishioners was tuberculosis, the cause of which was discovered by Pasteur in 1879. Vize became very interested in the Downy Mildew which occurred around the village. In one of his early papers he remarks that diphtheria was *"possibly caused by something living, possibly a yeast-like fungus"*. He was ahead of his time in his thinking because although he had no knowledge of bacteriology, he was very close to the eventual discoveries of Pasteur and Koch.

Vize concentrated mainly on rust fungi *(Uredinales)*, smut fungi *(Ustilaginales)* and downy mildew *(Peronosporaceae)*. Many of his specimens were collected in Montgomeryshire, locally around Forden and even in the Vicarage garden. John Vize published a number of papers on mycology and related subjects of interest. These appeared locally in the Montgomery Collection, the annual proceedings of the Powisland Club, as contributions to the Woolhope Club, and in specialist journals further afield. He enjoyed a reputation as a skilled mycologist throughout the country and was in demand both as a speaker on the subject and as a leader of fungus forays. Here he enjoyed conversation and debate with kindred spirits, especially on the subject of microscopic fungi.

Away from the world of mycology Vize did much to record the local history of Forden. One paper detailed the history of the Forden Union Workhouse, with graphic accounts of life, and death, in the workhouse. He wrote three papers in which he recorded the history of Forden, the first containing the natural history of the area, the second details the history of the church and the third is a general assembly of information about farm ownership, archaeology and customs of the village.

There is little to be found in Forden today to commemorate the life of one of its most notable residents. The church contains no memorial to the Vicar who served the parish for over forty years and was a Chaplain and a Guardian of the Forden Union. Vize moved to Bristol in 1910, living with his daughter in Clifton. He died in 1916 but his final resting place is unknown. Surviving records, both church and personal, give no clue as to the character of the man himself. His lasting legacy lies in the body of archive material which survives, a substantial testimony to the "amateur" naturalists of his generation.

Julian Lovell.

Abbey-cwm-hir.

Diamonds Pt. 2

Synthetic diamonds, a brief history. Pushing technology to the limit!

Early work

By the beginning of the 19th century, it had been established by Lavoisier and Smithson Tennant that, if diamond was burnt in oxygen, only CO_2 was produced. So diamond had to be a variety of carbon. How was the one converted into the other? Diamonds had been found in small quantities in widely different parts of the world, so there was little clue as to how or where they originated. However, in the late 19th century , after they were discovered near Kimberley, South Africa, geologists studied kimberlite, the host rock, and it became apparent that the source lay deep within the crust, where very high temperatures and pressures applied.This triggered the long quest to find a way of converting carbon into diamond, which was followed by a succession of brilliant, often eccentric and always obsessive scientists and engineers.

In 1880, one of the first was the Scottish chemist James Hannay, who filled thick-walled iron tubes with oil and lithium, sealed the ends, and heated them red hot in a furnace. The tubes often exploded, showering the lab with shrapnel. However, from three intact tubes, he managed to extract small crystals that he claimed were diamonds. Some of these were held in the British Museum, and have since been analysed and found to be natural diamonds. Maybe this was a hoax, or they may have been put in as “seeds”.

About ten years later, more famously, Henri Moisson built an electric arc furnace capable of reaching 3000 °C and experimented on making diamonds from graphite dissolved in molten iron. He did produce some hard crystals which he claimed were diamonds, but were more probably silicon carbide “Carborundum". His experiments could not be repeated.

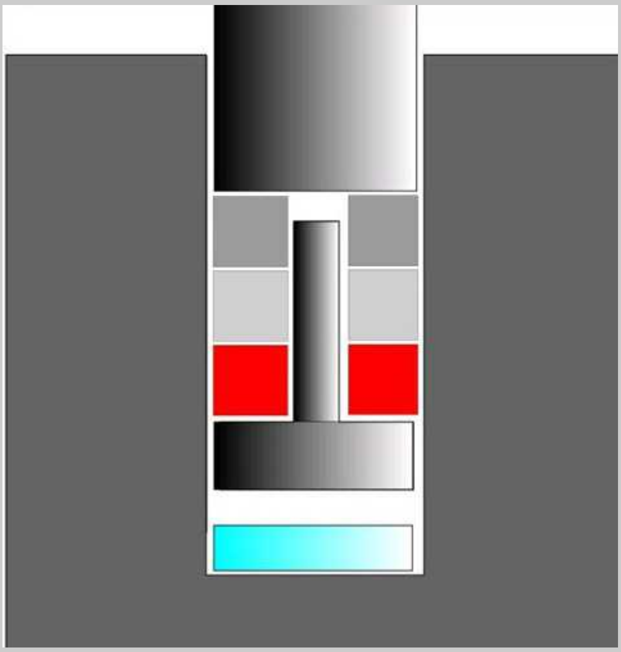
Sir Charles Parsons, the famous turbine manufacturer, became obsessed by making diamonds. He tried to form them by passing high electrical currents, up to 100,000 amperes through charcoal or coke under pressures as high as 12 kb (1.2 GPa*). After thousands of attempts over 30 years, he finally admitted failure. He did however write his experiments up thoroughly and they have been checked and repeated. As recent work has shown, he could not achieve quite high enough pressures.

The modern basis

The groundwork was carried out by Percy Bridgman. He was a remarkable chemist, a Nobel laureate, who is always associated with diamond synthesis; although he did not actually produce any. He did, however methodically explore the high pressure behavior of many materials and produced many high pressure minerals. Along the way he designed equipment which increased the achievable high pressures by an order of magnitude to several GPa* and which is essentially the basis for current “HPHT" (high pressure/high temperature) production.

Key to this is the “Bridgman Seal” which is now used for much high pressure work. This was based on the de Bange breech mechanism, a remarkable development used since 1880 up to the present day on field artillery pieces. We are all familiar with this as we see it on television on the Queen’s birthday. The guns used for a 21 gun salute have de Bange breech mechanism. (no excuse for not remembering his name!) De Bange made use of a mushroom -shaped nose cone which compressed a soft asbestos washer to seal the breech. Bridgman seals are similar, but use a graded seal (hard steel, soft steel and a softer material) in which the seal to the container is subject to pressure greater than the contained pressure. This pushed the pressure limits to about 10 GPa, the area of interest for diamond production, comparable to that deep within the earth’s crust.

The Bridgman seal.



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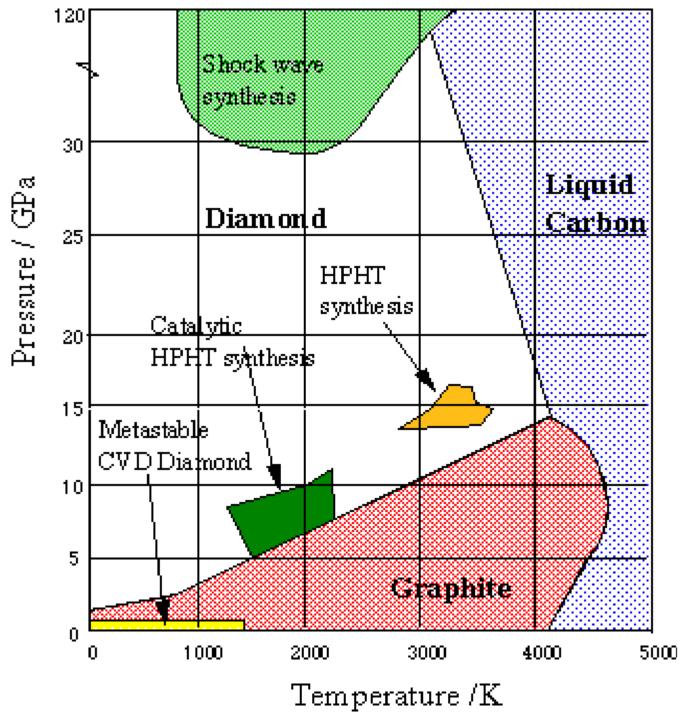
The aqua material is the specimen within a (grey) cylinder. The piston acts on a (grey) hard steel washer, a (light grey) soft steel washer and a (red) softer washer, all compressed by the mushroom shaped nosepiece. Because the washer has less area than the nosepiece, it is under greater pressure, so the specimen can not escape round it.

The second world war brought the realisation that diamonds are very much a strategic material. They are essential for precision manufacturing, particularly armaments. (If a round does not fit the gun barrel, there is a problem!) This, coupled with the tight cartel operated by de Beers, lead to a major effort in the US, to produce them.

Initially, Norton Abrasives' chemist, Loring Coes designed an improved high-pressure device that could be heated electrically to more than 1000 °C. In it he was able to form a wide array of tiny precious and semiprecious stones, such as garnet, topaz, and zircon, using pressures up to some 35 kb (3.5 GPa*); but no diamond! Further development was centred on GE's labs at Schenectady, where "Project Superpressure" was set up in 1951. After three years, in 1954, when management were on the point of cutting the programme, their physicist, Herbert Strong, loaded his press with carbon powder, seeded with two diamonds, surrounded by iron foil and ran it overnight at 4 GPa and 1250 C. Analysis showed small diamonds in the mass of iron. The next day, their chemist, Tracy Hall, ran his (different) apparatus at 7.5 GPa and 1200 C for 38 minutes. When he unloaded his samples, he found numbers of small diamonds. Strong's experiment could not be repeated, but Hall went on to produce batches, each producing about a quarter of a carat (50 mg).

The objective had been achieved and the HPHT process is now the workhorse of the industry, with many manufacturers operating. In general, iron or other metals, such as nickel are essential to the process, as catalysts, or



Phase diagram for carbon showing the stability areas for the different forms and highlighting the areas used for synthesis.

From Geophys. Res. 85 (B12) (1980) 6930.) Downloaded from: http://www.ch.ic.ac.uk/rzepa/mim/century/gifs/cphased.gif 12.04.2016

solvents. One can think of the carbon as being dissolved in the iron and crystallising out like salt from a saturated solution.

Technically, the first synthetic diamonds had probably been made by the Swedish electrical company ASEA. Together with the inventor, Balthazar von Platen, ASEA, during WW2, developed a press heated by "Thermite" which produced pressures of 80 kb (8 GPa) and temperatures of 4000 C. They had little success until 1953 when, with iron carbide as a carbon source, they produced sand sized diamonds. They repeated the experiment, but for reasons never explained, they did not publish until 1960, long after the GE success. Most recently, Chinese producers have brought prices down to the present low, making diamond tools very affordable. Diamonds have now been produced by a variety of processes, best illustrated by the phase diagram for carbon which shows the stability regions for the different varieties, with the areas used to synthesise diamonds highlighted. Note that, although diamond is the stable form under many conditions, high temperatures are necessary to enable reaction at a reasonable rate.

Chemical Vapour Deposition

This process, in contrast, is carried out at low pressure, in an atmosphere of hydrogen and methane. A plasma dissociates hydrogen into active atomic hydrogen which blows apart the C-H bonds in methane and enables C to reform on a suitable substrate as diamond. Usually this is polycrystalline and is used for example for hard coatings and microelectronics; but it can also be deposited on diamond to produce larger gem quality stones.

Detonation and ultrasound diamonds

Exploding TNT in a reducing atmosphere can produce nano-sized diamonds which have many projected uses, from polishing to tungsten wire drawing and in medicine. In a similar way ultrasound cavitation, laser and "microplasma" techniques are said to be possible methods for making nano-diamonds. It seems that diamonds are produced by a host of "extreme" processes. In nature they are produced in meteoric craters.

Tony Thorp

*GPa The gigapascal, and the pascal, may not be familiar as units of pressure. The pascal Pa is the SI derived unit of pressure and is equivalent to one newton per square metre -
What's that? Pressure units are a mess! I put 43 psi in my van tyres, that is about 300 000 Pa, or 0.3 megapascal, or 0.0003 gigapascal. So next time you want your tyres seen to, ask for 300 000 pascal! 43 psi is also about 3 bar, 3000 millibar, or roughly 3 atmosphere.

Geological Excursions

Sites to visit.

Excursion Number 5

The Severn Valley at a Slow Pace

We all use it and know every bump and cat's eye; but we can also travel from Newtown to Welshpool the slow way. A bicycle or Shanks' pony is a great way to relax and appreciate time, not on the A483, but on a route from the past, along the canal. If energetic, one can walk from Newtown, but we will take it easy and take the stretch from Abermule where we are in the presence of structures from deep geological time (Severn Valley Fault System) to recent history (Thomas Penson's cast iron bridge over the Severn), via the Devensian Ice Age (ca 20,000 years ago).

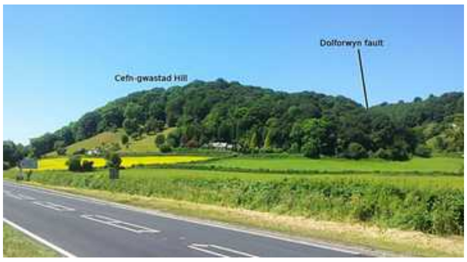


Figure 1.

If we are lazy, we can use the lay-by parking near the Brynderwyn bridge (SO162953), walk to it and descend a slope to the towpath; but first, before leaving the main road, look southwest (SW) to Cefn-gwasted hill **(Fig. 1)** which is decidedly drumlinesque, but is rocky and has been extensively quarried (you can't see them as they are well grassed over). You could therefore call it a rock drumlin. Just behind it is another drumlinesque hill on which sits the Welsh castle of Dolforwyn, constructed about 1275. Between them runs the Dolforwyn Fault, a splay fault off the Severn Valley Fault, which runs along the gully between the two. On the geological map this col is marked as a meltwater channel. This could be so, if ice dammed up against the rocky Cefn-gwastad hill, it would overflow down the col.

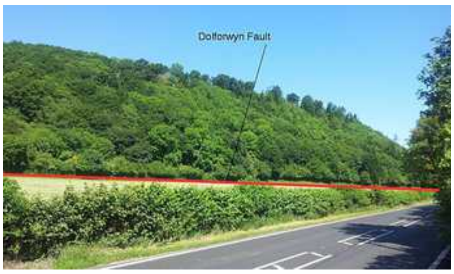


Figure 2.

If you cast your eye round towards the N, you can see the edge of Dolforwyn Woods (now a nature reserve) as it runs down to the main road. This follows the change of slope caused by the fault **(Fig. 2)**. This Caledonian fault system is a weakness exploited over hundreds of millions of years. Indeed, we still get small shocks at intervals.

The builders of Dolforwyn Castle had everything going for them. The castle hill had over-steepened sides due to the fault and glacial erosion. The rock exposed at the summit was the Nantglyn Flags formation which is not an ideal, but is a reasonable building stone which was easy to quarry with a hammer and bar. Levelling the top of the hill would have provided an initial supply of building stone.

Figure 3.

Going down to the canal, we can appreciate Penson's bridge **(Fig. 3)** then turn right to go under the canal bridge (also Penson's). As you walk along, look through any gaps in the hedge on the right at the hills to the SW of the river and note that they generally preserve the drumlinesque shape.

Figure 4.

Keep an eye on the far side of the A483 and you will see a repeat performance as you approach Glanhafren Bridge. Again you have the wooded area ending at the break in slope at a fault. This time it is the Glanhafren Fault. **(Fig. 4)** Vaguely parallel to the Dolforwyn Fault, these are two of the system of faults forming the Severn Valley Disturbance. They approach the line of the disturbance asymptotically. When you come to the Red House Nature Reserve, you get a better view of the drumlinesque hills to the SE by Cefnbryncalch.

Shortly, the canal crosses the A483 where they levelled it with no bridge, to save money. The choice is then whether to return the way we came, or go further and get a 'bus back! We can take the next section another day.

Tony Thorp

What stopped Offa?

A political boundary determined by geology.

Convention sees the construction of Offa's Dyke in the second half of the 8th century as the original established frontier between England and Wales or more accurately between the Anglo-Saxon Kingdom of Mercia under King Offa and a number of Welsh kingdoms. But why did Offa stop where he did? I believe that its history in one sense can be traced back geologically about 460million years, and well south of the Equator. It was then that the earth movements of the Caledonian orogeny (mountain building) began to affect the continental margin of Avalonia as it was driven northwards by convection currents in the Earth's mantle to collide with Laurentia, ultimately obliterating the Iapetus Ocean.

Although today we see the main effect of the Caledonia orogeny as the folding and uplift of the pre-existing sea-floor sediments of Snowdonia, the Lake District and Scotland, there was within the western margin of Avalonia, a deep Welsh Basin, the eastern margin of which we now recognise as the Church Stretton and Pontesford-Linley fault lines. Within this Welsh Basin there accumulated deep water sediments interspersed with volcanic activity. This factor is clearly demonstrated by the nature of the Ordovician and Silurian rocks laid down at the time. (**See Fig. 1**).In particular, on the continental shelf to the east of the fault, one sees a typical shallow water stratigraphy most clearly illustrated in the Wenlock Limestone.

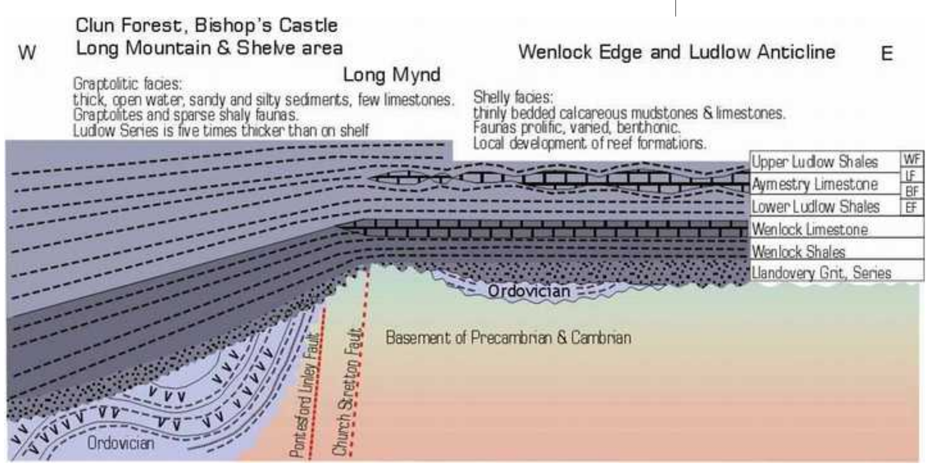


Figure 1.

Towards its most easterly outcrop at Wren's Nest in Dudley, and at the north eastern end of its Shropshire outcrop along Wenlock Edge we find the classic coral reefs **(Fig. 2)**, fossilised in situ and contributing to a considerable thickness of pure limestone. As the outcrop of Wenlock Limestone is followed south westwards, the amount of reef limestone diminishes. Whilst further west still the Wenlockian period is represented by altogether deeper water sediments, under a completely different nomenclature, in which we find the Penstrowed Grits. This formation shows numerous graded beds fining upwards from coarse grits to finer sandstone layers, each cycle being 4 to 8cms in depth, representing slumps off the continental shelf into the Welsh Basin. (**Fig. 3**)

Figure 2.

Figure 3.

The failure to appreciate this stratigraphically is well illustrated in William Smith's first geological map of England and Wales published in 1815 on which the recognisable outcrops of limestone are clearly marked, though no distinction in age is drawn between the Silurian Wenlock Limestone and the much later Carboniferous Limestone. Whilst almost everything west of "the Dyke" is lumped together as *"Red Rhab and Dunstone, with interspersions of Limestone" to a point slightly west of Offa's Dyke; before giving way to "Killas or Slate, and other Mountain Strata abounding with Minerals"*. If you look at Murchison's later map of 1838 you find considerably more detail in the classification of the Marches, with sub-divisions of different rock types and stages within what he classified as the Silurian System (which included what we now refer to as Ordovician for the earlier strata). However there is still no accurate sub-division of what we now call the Ordovician and below that the Cambrian.

However, Offa was of course totally unaware of any aspects of academic stratigraphy! He was only seeking a defendable boundary at the margin of that region in which an Anglo-Saxon agricultural and settlement pattern could become established. This evolved into a pattern of a nucleated village on land granted to the Lord of the Manor which could be divided into three or four fields cultivated on a strip system for the growing of all crops required by the parishioners. Land unsuited for crop growing within the parish was common land on which parishioners could graze their animals.

I suggest it was primarily these criteria which dominated Offa's thinking. Go up onto the higher parts of Offa's Dyke **(Fig. 4)** today and you are immediately struck by the differences in topography and land use between the view eastwards (into England) **(Fig. 5)** and westwards (into Wales) (**Fig. 6**). Additionally Offa required his boundary to be easily defensible, so his dyke is usually on the western slope of hills, giving a clearer view of any advancing threat from the Welsh.

Figure 4. Offa's Dyke across the Clun Forest

Figure 5. Clun valley east of Offa's Dyke

Figure 6. Clun valley west of Offa's Dyke

I had always been aware of the practical reality of this ever since I moved to Church Stretton in 1969. I was surrounded by Precambrian and Lower Palaeozoic rocks but of sufficient variety of type to give a distinctive north-east to south-west lineation to their outcrop, and none except the Long Mynd of such an extent as to dominate large areas. Over the years the establishment of parish boundaries had ensured that each parish had a share of several types of land within it.This is most conspicuous in the hills to the east of the Church Stretton valley. **(Fig. 7)**. The parishes tend to be elongated from north-west to south-east, embracing the fertile soils and fairly level ground on the weaker, drift covered rocks of the valley floors and the resistant ridges of the stronger rocks. For example, parishes in Ape Dale run up to the top of the well wooded face of Wenlock Edge, and sometimes beyond into Hope Dale. Bordering them to the south-east a similar line of parishes run down onto the more fertile soils over the Aymestrey Limestone ridge, to continue down the gentle dip slope of the Upper Ludlow shales to the rich pasture land on the red clay soils of the Devonian (Old Red Sandstone) of Corvedale. East again Shropshire's highest hill, Brown Clee, is encircled by parishes each with a share of the lower and flatter shelf of Old Red Sandstone around the hill, then common land on the rough grazing of the uppermost ORS and Coal Measures with their boundaries meeting along the summit.

West of the extensive Long Mynd plateau the average elevation of the land increases but with sufficient deeply incised glacial valleys with wide enough fertile valley floors and lower slopes to allow a similar nucleated parish pattern, certainly as far west as the prominent craggy ridge of the Stiperstones. On the west side of the ridge exploitation of mineral wealth, in Roman times and again from the sixteenth to the late nineteenth century allowed the development of many sustainable communities though often of a more scattered nature. Significantly many of these communities became deserted with the demise of mining.

As one moves further west the valley of the River Severn through Welshpool and northwards as far as its sharp easterly turn around the north side of the Breidden Hills, appears as broadening lowland. But as floods can easily demonstrate, that is a bit deceptive when it comes to settlement, for this glaciated valley has the present day meandering Severn running through it, flanked by what, in Offa's day, would have been wide areas of marshland.

Figure 7. East of the Stretton Hills - from Caer Caradoc to the Wrekin. Prominent ridges but cultivable valleys.

So again Offa obviously considered it best to keep an eye on this from the western flanks of the higher ground between Forden and Buttington. North from Buttington there is less clear evidence of any Dyke crossing the river, but a few sections are traced northwards across the Vyrnwy valley and up to Llanymynech. Here, true to form, it can traced high up on the western side of the steep Carboniferous Limestone escarpment of Llanymynech Hill before continuing almost due north on a similar line close to the unconformity between the base of the Carboniferous to the east and the much folded Ordovician and Silurian to the west.

While I concede that Offa had no direct knowledge of the underlying geology in scientific terms, I believe that the effect of rock in shaping the landscape had, and arguably still has, a major influence on the way that humans have colonised the land in tune with their respective civilisations. Today, when political ambition has less to do with conquest and more to do with economics, the driving forces of settlement and planning are less concerned with communal self-sufficiency and more to do with the protection of "scenic landscape" and "nature". But I can assure you from personal experience of moving to a small holding above Llangadfan, 15 miles west of Welshpool and 300 metres (1000 ft) above sea level, that the natural demarcation of the rock beneath the soil remains clearly visible in the use of the local landscape. I was using a road atlas while showing a neighbour where we were moving to when I was struck by the fact that it was on the "edge of the known world"!

Figure 8. From above our house - view ENE to Breiddens

Figure 9. From above our house - view WNW to The Arans

Andrew Jenkinson

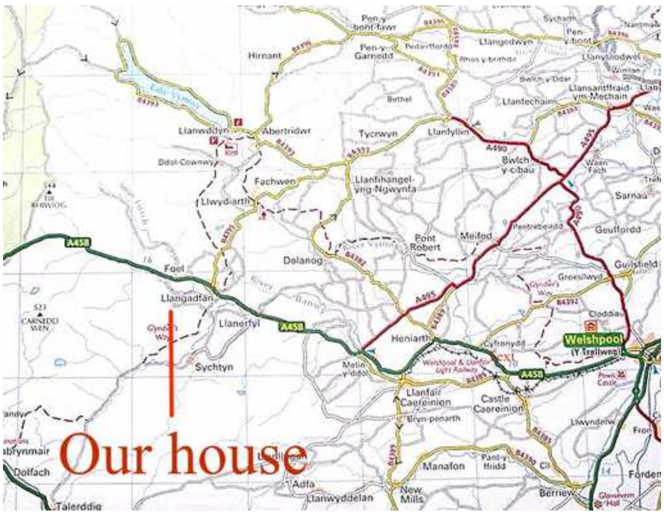


Figure 10. The edge of the known world.

The Acadian Orogeny -
A Speculative Cause.

Perhaps the main folding of Wales was not due to the collision of England and Wales with Scotland

The deformation seen in our Welsh Silurian rocks was caused by the Acadian Orogeny, an event until recently thought to be the final convulsion of the Caledonian Orogeny, and the culmination of closure of the Iapetus Ocean and collision of East Avalonia with Laurentia. Is this so? Probably not. It was first questioned in 1987, with the realisation that the Iapetus closed around 420 Ma in Wenlock/Ludlow times, but the Acadian deformation phase occurred in England and Wales between 400 and 390 Ma, at least 20 Myr later. The accuracy of radiometric dating of white micas in the cleavage impressed on the Acadian folding improved during 1987-2003, allowing folding to be constrained to approximately 394 Ma. This disconnection of Acadian shortening from Iapetus closure was confirmed by 2003 with the recognition of a transtensional phase in England and Wales after Iapetus closure, rather than a compressional phase with uplift, as previously thought. This is also consistent with the deposition of a lower Devonian succession of sediments. All that was needed then was an explanation for the much later occurrence of the Acadian event. This came with a reinterpretation of the Acadian Orogeny in Woodcock et al. (2007).

Woodcock considers the most likely cause of the Acadian Orogeny to have been a northward subduction of the Rheic Ocean floor beneath the southern edge of Laurussia, the continent formed by the collision of Avalonia with Laurentia. The Rheic Ocean lay between Avalonia and Gondwana, having been opened by a much earlier rifting between the two. The Rheic continued to widen as Avalonia moved north and closed the Iapetus. In the latter stages of Iapetus closure, the Rheic also began to close by northward subduction beneath Avalonia, southward subduction of the Iapetus beneath Avalonia by then having ceased. When the original spreading ridge of the Rheic began to subduct beneath Avalonia it was still warm enough to be bouyant and resist subduction. This caused the dip of the subducting slab to flatten. When a subducting slab dips steeply it causes tension in a back-arc basin (as in the Welsh Basin). But flat slab subduction beneath Avalonia compressed the lithosphere and folded Wales (strictly it was sinistral transpression because it also forced a large strike-slip sliding movement on the pre-existing lineaments). According to this conjecture the flat slab subduction created enough friction to shorten the crust of Central Wales by as much as 40 percent.

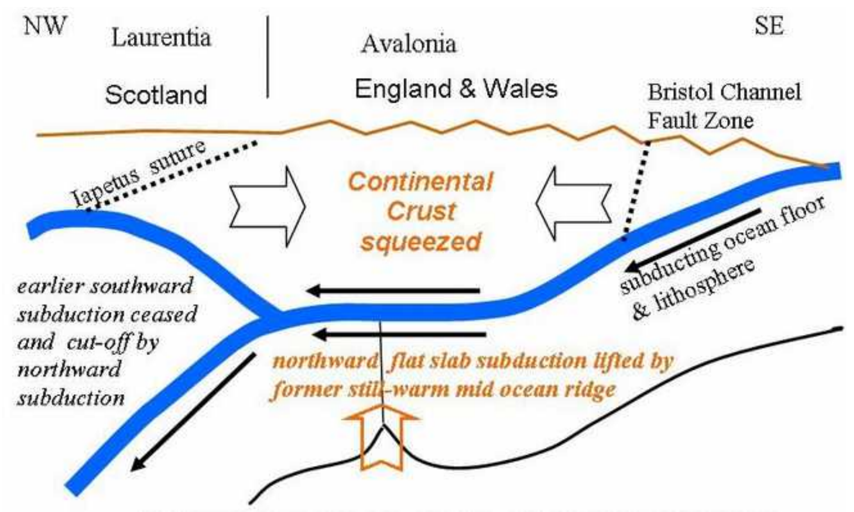


Figure 1. Cartoon of flat slab subduction.

A second possible cause of the Acadian Orogeny is conjectured by Woodcock, namely a collision between the Avalonian terrane and a continental fragment containing Iberia, and Armorica (including Normandy). This he thinks less likely because of the absence of extreme crustal thickening which normally accompanied a continental collision.

Woodcock observes that the main problem with a Rheic Ocean hypothesis for Acadian deformation, is the missing arc and forearc terrane that should lie on the southern margin of East Avalonia as a result of the Rheic subduction there. This would normally include evidence of arc volcanism, and a downward flexure basin caused by loading of the subduction front, together with associated flexural uplift behind the front. Instead there is the Cornubian terrane (Cornwall, Devon, Dorset, most of Somerset and a corner of Hampshire, plus the Isle of Wight) which lacks arc and forearc evidence as well as lacking Acadian deformation. He conjectures therefore that, during the Devonian period, the Cornubian terrane lay some 400 km to the south east; and was translated to its present position by dextral slip, north-west along the Bristol Channel-Bray fault during the latest Acadian period, or at some point during the Variscan Orogeny (Gondwana-Laurussia collision 380-280 Ma).

Woodcock points out that this conjecture also solves another problem: the mid Devonian Acadian mountain belt must have shed large volumes of sediment southwards, little of which is now preserved in the south-west British geological record. This is probably because it was shifted north-west along the Bristol Channel-Bray Fault during the same dextral movement which brought the Cornubian terrane to its present position in late Carboniferous times.

The absence of earlier deformation in Wales concurrent with Iapetus closure is thought to be due to a 'soft' collision in Eastern Avalonia. A 'harder' collision, with associated deformation, was experienced in Western Avalonia (the Appalachian Mountains), and to the east, where Baltica by this time partly adjoined Avalonia. These areas were salients on the colliding front and therefore bore the brunt of the collision, protecting Eastern Avalonia from collisional deformation.

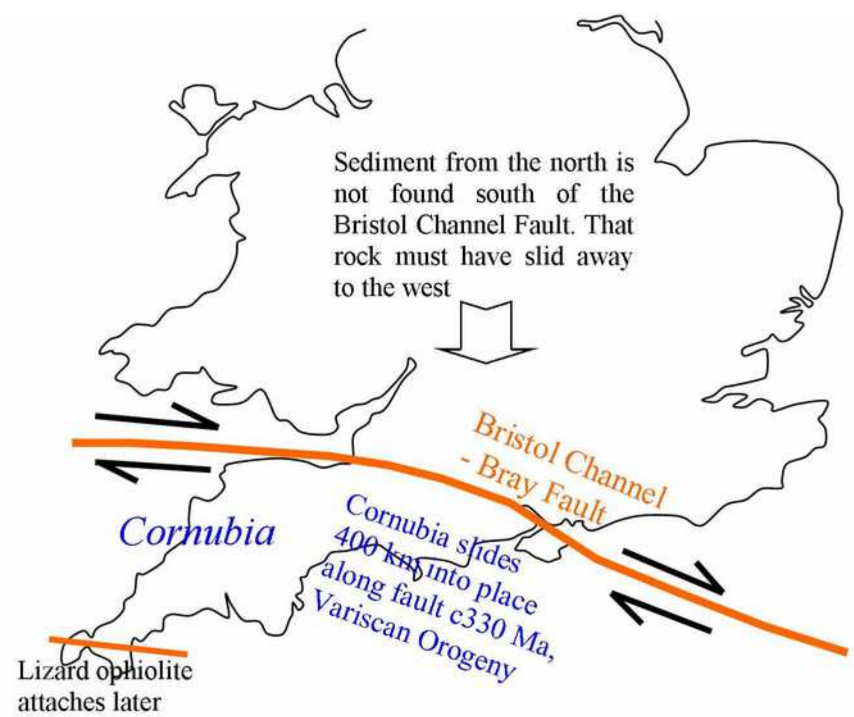


Figure 2. Bristol Channel fault.

Colin Humphrey

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Bill's Rocks and Minerals

Barite / Baryte / Barytes.

In the past, there has been some confusion whether to name the mineral barite, baryte, or barytes. The International mineralogical association (I.M.A.) has decided to use the name baryte as standard, which is the English version. The Americans aren't too happy that it was chosen over barite, which was their version. An old fashioned term for baryte, which is sometimes used, is "heavy spar". The Greek word for heavy is barus from which baryte derives its name. Baryte is the principle ore of barium, with the formula $BaSO_4$ (barium sulphate).

Tabular crystals of baryte

The most striking physical attribute of baryte is it's heavy weight. This is very noticeable on handling a specimen. It has a specific gravity (S.G.) of 4.5.This is greater than quartz which has an S.G. of 2.65. Even though it is very dense it has a very low hardness of 2.5 on the Mohs scale, again compared with quartz which has a hardness of 7.

An important feature of baryte is that it is insoluble in water making it particularly useful when it is used as an additive in many manufacturing processes, including paints, electronics, T.V. screens (not so much now), rubber, cosmetics, and paper. High quality playing cards have quite a high content of baryte to give them extra weight, and make them easier to deal. However, the bulk of baryte produced, 77%, is used as a weighting agent in oil and gas drilling heads, where it is mixed with muds, and pumped down the drill stem where it exits and returns to the surface in the space between the drill stem and the well wall, carrying rock fragments from the drilling process as it does so.

Cockscomb variety from the Bryntail Mine.

It is also used to make barium compounds which are used in the shielding of x-ray and gamma ray equipment in commercial and hospital use. Diagnostically, barium is used as an additive in drinks and enemas to highlight soft tissue which would otherwise be difficult to image.

The Uses of Baryte	
Oil and gas drilling industry.	69%
Chemical Industry, ceramics, electronics, glass industry	15%
Filler in rubber, paint, paper. Filler in radiation shielding.	16%

China and India are the worlds leading suppliers of baryte. The U.S. produces only about 25% of its domestic requirements, and so it is a major importer, whereas the UK is self sufficient with major mines in Scotland, and smaller mines in the North Pennines.

The major mines in Scotland are Foss mine and Duntalich mine. The Foss mine was the first to produce baryte in large quantities, but since plans were approved in Sept 2016 to open a mine at Duntanlich, near Aberfeldy with it's estimated reserves of 7.5 million tonnes, the UK needs for the next 50 years are assured. The mine is planned to open in spring 2018 and will produce about 3 times the amount of the Foss mine.

The origin of Baryte in the Foss and Duntanlich mines is from sedimentary deposits in large scale recumbent folds in the southern outcrop of the Dalradian sediments. When black shale was being deposited under anoxic conditions, metal rich hydrothermal brines were injected into the sediments, releasing the various minerals, of which baryte is one. The source of the heat which prompted this process was related to the Tayvallich volcanism 600Ma.

Baryte is also common as concretions in limestone and dolostone. When these carbonate rocks are heavily weathered, large accumulations of baryte can sometimes be found at the bedrock-soil contact. A number of mines exploit these residual deposits.

A totally different source of baryte is from hydrothermal ore deposits. For example, the Bryntail mine in the Central Wales Ore field produced several thousand tons of baryte in sporadic activity from such a source in the second half of the 19th century. This is just one example of many mines scattered throughout the UK, especially central Wales, Shropshire, and Pennine ore fields.


Desert Roses

Sandstones can also be bearers of baryte, indeed some sandstones are so rich in baryte that it acts as a cement for the sandstone. It is from the baryte rich sandstone that interesting growths of baryte known as desert roses are found. These are formed as baryte crystals incorporate sand grains in their growth.

Baryte crystals are classed in the orthorhombic system, and in the dipyramidal crystal class. Its crystal habit is tabular, and varies in colour with yellow, red, and green varieties, caused by trace elements of other minerals. It can be found in its pure state as completely colourless and transparent. Groups of plates can form fan shapes to create the varieties known as "cockscomb", or rosettes "desert roses", which are common in Oklahoma, and the Sahara desert. "Bologna Stone" is a variety of baryte found in nodular-fibrous, radial formation or concretions on the hills around Bologna Italy with the Argille-Scagliose Formation.


Bologna Stone cross section. The University of Bologna/Creative Commons.

Bill Bagley

Radiating crystals.

Free Geological Maps from the BGS

In the past we have had to buy a geological map sheet from the British Geological Survey, costing typically around £14. It is costly to do this for every area we visit. Not anymore. BGS have introduced a scheme under which almost all their published 1:50000 maps can be downloaded online free of charge.

Go to the **BGS Maps Portal**
Scroll down to quick link to 1:50000 maps and click that, or navigate from the left side menu.
This takes you to the multi-page list of 1:50000 maps. It helps if you know the title, or you can search through the whole list. Click 'Full Entry' under the map you want. You get the map details.
Then click 'View Map' and up it comes!

The whole map appears on a single page, much too small to be studied. You must zoom to the bits you want, but the reproduction after zooming is very good.

Colin Humphrey

The most recent maps are not on the site. Sheet 164 Llanidloes (2010), and Sheet 150 Dinas Mawddwy (2012) are not there yet, nor is Sheet 180 Knighton (an area still unpublished), but every other sheet for many miles around here seems to be there. This is a wonderful facility. BGS are to be congratulated. Again, remember that copyright provisions apply.

Members Photographs

Textbook U-shaped glaciated valley.

Cwm Cywarch, south of Aran Fawddwy, photographed from the foothills of the mountain, around grid ref. **SH 850 203.**

Chris Simpson

Exploring the Building 'Stones' of Llanidloes.
Part 2: Bricks

A previous article looked at the use of natural stone in the buildings of Llanidloes (*Silurian* issue 1). This article will concentrate on the use of bricks as a building material, their history, manufacture and use in architectural design.

Bricks are an ancient building material and bricks dating back thousands of years have been found in the Middle East. These bricks were made from river clays/muds mixed with chopped straw, hand-moulded and sun-dried. Since that time, bricks and their manufacture have evolved to meet the needs of society, changes in technology and fashion.


Roman Brickwork. Creative Commons.

It was the Romans who first introduced kiln-fired clay bricks into Britain. The commonest Roman bricks were really a tile, called the *lydium,* measuring 18x12x1.5inches. When the Romans left, brick-making disappeared until the technology for making bricks was re-introduced to East Anglia in the 13th century from northern Europe. This is thought to be related to the strong trading links of the Hanseatic League trading from the Baltic through ports such as Hull, Kings Lynn and London. These bricks were different from the Roman ones; brick sizes generally ranged from about 8½ x 4 x 2 inches to 10 x 5 x 2 inches. The size was geared to a man's hand, if the brick was large it could not be held in one hand whilst the other hand held the trowel for applying mortar and if too small it would increase the number of bricks and the amount of mortar to be used which would increase costs. A charter of 1571 stipulated that bricks had to have dimensions of 9 x 4.5 x 2.5 inches. By the 18th century sizes had altered and methods improved. In 1769 Parliament legislated for an 8.25x 4 x 2.5 inch brick and in 1784 introduced the brick tax (a property tax) to mitigate the costs of the War of Independence.

Background image.

House wall with machine-made bricks (left side) blended into an older wall of hand-made bricks (right side) .

Photo ©Richard Becker

This caused bricks to increase in size and are known as "tax bricks". The tax was repealed in 1850. The modern brick is now a metric measurement the usual size being 215 × 102.5 × 65mm.

An early example of the use of brick is in Tattershall Castle in Lincolnshire (1435). In north Wales it is thought that the earliest houses to be made from brick are Bach y Graig, Tremeirchion (1567-9) and Plas Clough (1567) near Denbigh built by Sir Richard Clough. Whilst in mid Wales the earliest brick building seems to be a brick house built by Sir Edward Herbert's grandson in Montgomery Castle, in 1622-5. (CPAT). The house had walls of brick and timber including the use of ornamental brick. It is thought the bricks and tiles for this work was based on the traditions and skills in the adjacent county of Shropshire where the industry is known to have originated before 1540.


Vaynor Park. Creative Commons.

Other early brick-built residences in mid Wales are; Vaynor Park, Berriew (c1650), Llandrinio Hall (c1670), and Criggion hall (c1675) (CPAT).

As time progressed brick became more commonplace and much less a status symbol. It also had the advantage that the use of local clays meant it could be dug and manufactured on site, so lessening cost and time. Locally, glacial clays and alluvial clays of the river Severn would have been used and the existence of clay pits can be found in names like "Brickfield"," Cae Brics"and "Brick Kiln Field". As bricks were heavy and the condition of the roads appalling, transport of bricks was severely restricted. This led to the development of the country brickyard most of which were small and known as "summer yards" using the technique of clamp burning, in which green bricks were placed on a floor of fired bricks which had channels for the fuel with more fuel placed between the green bricks. The whole being encased with either turf or more burnt bricks and a clay matrix and left to burn. This type of brick making, by hand, was a seasonal occupation: autumn was for excavating the clay; the winter frost was utilised to help break up the raw material; spring through to summer saw brick moulding, drying and firing. These small brickworks would supply local builders within a radius of a few miles. In addition to these independently owned works, there were the brickyards of the larger estates and those that belonged to farmers. Also, due to the difficulty in transporting bricks it was often better and less expensive, to employ an itinerant brick maker to make bricks on the site itself.

In Llanidloes the use of hand-made bricks can be found in some early brick built buildings. The Trewythen was built between 1763-79 for Gerald Valentine Jones as a private residence, but is now an hotel. The clay for the hand-made bricks is thought to have originated from land at Morfoddyion just outside the town. Another early building is 44 Longbridge Street, built in the late 18th century, by Edward Parry. Numbers 22-25 Bethel street were built c1810-20 and are contemporaneous with a warehouse that is situated in the courtyard behind the houses which was built as a small weaving factory. It was later converted into 2 cottages and then in 1926 it became a corn mill and underwent various alterations. In 1833 David Davies (industrialist) built a short terrace of houses, from local brick, on what is now the High Street (numbers 7-10). (CPAT).

Hand-made bricks have a problem in that they vary in size and quality due to the inherent nature of their manufacture and it was only with the onset of mechanised brick production that a uniformity and quality began to appear.

During the industrial revolution there was a massive movement of people from country to towns and cities which spurred vast building programmes. Better transport infrastructure with roads, canals and later railways, gave brick-makers the opportunities to establish permanent brickyards and with the development of steam power and engineering, machinery was developed to speed up the process. By 1850 the majority of brick-makers used mechanised brick production. Without this step-change in brick manufacturing it is uncertain whether towns would have been able to expand so quickly. By then clamp firing was less common, with the major brick manufacturers producing large numbers of bricks in down-draft kilns, with the bricks separated from the burning fuel by a low perimeter wall. This resulted in a product of more uniform quality and colour. Production became more efficient following the introduction of continuous firing kilns in the mid-19th century, such as the Hoffman kiln. Firing occurred in successive chambers in rotation, with the heat from one firing being used to preheat the next one.

Bricks as an architectural feature on chimneys. Penygreen Lane, Llanidloes. Photo ©Richard Becker.

The prosperity and wealth of Llanidloes increased early in the 19th century due to trade in flannel and woollens, which was followed by the opening of the Van mines in mid-century. The increase in wealth coupled to the town developing rail links north to Welshpool and therefore north Wales and Staffordshire and south to Builth Wells and therefore south Wales, meant that bricks could easily be imported from these areas in large numbers and at lower cost. The bricks now used for the homes in Llanidloes would have been machine made and probably imported from north Wales and Staffordshire, although some local brickworks were established, for example Buttington Brick Works near Welshpool (established 1896),which used local shale (Telychian Tarannon Shale Formation), Park Brick and Tile Co. Newtown (established c1892) , and Newtown Brick and Tile works, which probably utilised local clays.

In the early brick-built houses in Llanidloes the bricks were red in colour but the ability to import bricks from

Hoffman kiln, Llanymynach. Although this example was a lime kiln, the same design was used to fire bricks. Photo ©Richard Becker.

a distance allowed builders to use bricks of different colours giving individual character to a building. The development of colour in a brick is complex but is related to the mineralogy of the original clay, the firing temperature and atmospheric conditions in the kiln, although nowadays mineral colourants are often used. Iron minerals in the clay provide the red colour. In an oxidising atmosphere iron-bearing minerals will convert to haematite,with the depth of colour increasing with increasing firing temperature beyond 1000^{o}C. Mineral fluxes, quartz and clay minerals containing no iron, are also important because they may react with the iron-bearing minerals to form other coloured compounds or glasses. Blue colours are produced in a reducing atmosphere which is obtained by either setting the bricks close together in the kiln thereby decreasing airflow over the bricks or by controlling the fuel supply causing all the O_2 to be burnt. This latter method is known as “flashing”. In the reducing atmosphere the iron will combine with the silicates present in the clays forming ferrous silicates which, unlike haematite become liquid at kiln temperatures therefore forming a dark blue skin on the brick. Vitrified on the outside the brick will have a very high crushing strength,and low porosity therefore making a good engineering brick. The Staffordshire -Blue bricks, made from “Etruria Marl” were used for the construction of almost every railway, road and canal bridge in the West Midlands and indeed in most other parts of the country.

Polychrome effect from coloured bricks on adjacent houses. Short Bridge Street, Llanidloes. Photo ©Richard Becker.

Pale coloured bricks are produced from clays with a low iron content (fireclay and ball clay) or from clays in which sufficient calcium has been added. This leads to the production of calcium-iron silicate minerals. The above colours will be “ through” colours but surface colouring may be achieved by adding certain metallic oxides either to the sand prior to firing or applied as a glaze. Manganese will produce brown, chromium - pink, antimony- yellow, copper- green, cobalt- blue and manganese and cobalt combined – black. In fact colours for bricks is quite a big business with companies producing the coatings and other additives to produce a vast array of effects and colours of brick. According to “Ibstock” (brick manufacturers Leicestershire) coloured glazed bricks are now being used by architects to create “stand-out-design” in buildings.

Although in recent times the use of brick has declined as newer materials come onto the market, brick still forms an important role in the built environment. Most of the bricks produced are still made from clays but a new breed of brick is entering the market. These bricks are made from recycled materials. For example “Green Leaf” bricks are made from 100% recycled materials. These materials are rescued from landfills, open pit mining byproducts and plant refuse, which includes processed sewage wastes, recycled iron oxides, recycled glass, mineral tailings, and other virgin ceramic scrap. All of the materials used in Green Leaf Brick can be classified as post consumer or post industrial (pre consumer).

On a totally different plane, a team of engineers at the University of California San Diego and funded by NASA, have been studying a means of turning martian soil into bricks in order that manned missions could build places to live. They came to the following conclusion: “*Explorers planning to settle on Mars might be able to turn the planet's red soil into bricks without needing to use an oven or additional ingredients. Instead, they would just need to apply pressure to compact the soil -- the equivalent of a blow from a hammer.”*(Science daily 27/04/2017)
The humble brick is going places!

Michele Becker

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Caen Stone

At a club lecture earlier this year there was a discussion about the use of Caen stone, especially in ecclesiastical buildings. Along the Sussex coast many of the churches from the early 12th century onwards have Caen stone arches and quoins.

Flint wall with Caen stone doorway. St Peter's Church, East Blatchington, Sussex.

Caen stone is a middle Jurassic limestone sourced from underground quarries in Normandy. After the Norman conquest the Normans imported their own stone-masons and their preferred stone from Normandy to build Cathedrals and castles.

Around Seaford the local building material is flint, Seaford being at the coastal side of the South Downs there would have been no other local stone, or much wood available in the Medieval period (and much later as well). Of the older structures the domestic buildings generally have brick quoins, with Caen stone quoins in the churches, much of which has weathered badly. The bricks were presumably hand-made locally, but Seaford was formerly a Cinque Port so the stone would have come direct from Normandy.

All the sources I have found use almost the same phrase about Caen stone in England; "brought back as ballast". But 'ballast' implies weight of no value added

12th Century Caen stone arch (with repaired facing?) in the south side of the tower of St. Leonards Church, Seaford.

to the hold in order to trim the ship. I have tried to look for, but cannot find, any source for the statement. It seems strange, if we assume the main export in the late Medieval period was wool, a light, but bulky, high-value cargo, surely the ballast would have been required on the outward journey? There would have been no shortage of heavy products of high-value to import on the return. If Caen stone was regarded as ballast it's use (sparingly) solely in high-status, expensive buildings seems illogical. Surely it would have been used in more vernacular buildings instead of the local bricks? In the 13th Century Seaford port was a major exporter of wool, and importer of wine. On a weight for weight basis Caen stone must have had a value at least equal that of wine to justify bringing it back in any quantity.

Richard Becker

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Seaford Heritage Trails

The Corpus of Romanesque Sculpture in Britain and Ireland.

Caen Stone – From the Dinosaurs to the Cathedrals Exhibition

Feudalism - The History Learning Site

Members Photographs

I bought this little assemblage of fossils from a charity shop in Kington a few months ago. As it was all in Hungarian I translated it using Google translate:

"Maritime sea shells, 5 - 15 million years old, found embedded in seceded formations of surface debris from the Miocene and Pliocene, in the Fertorákos Quarry, Hungary. By the late Dr. Jozsef Kokay, Geologist."

Janey Haselden