Fforwm Cerrig Cymru Welsh Stone Forum

NEWSLETTER

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Welcome to the 14th edition of the Weslh Stone Forum *Newsletter*. This is the largest we have produced to date and reflects the increasde activity and willingness of members to write up their studies and observations. We have a full programm of field meeting this year.

Subscriptions

If you have not paid your subscription for 2016 please forward payment to Andrew Haycock (andrew.haycock@museumwales.ac.uk).

PROGRAMME 2017

April 29th AGM & Annual Lecture

The 2017 AGM, will be held at 11.00 am at St Michael's Centre, Llandaff, 54 Cardiff Road, Llandaff, CF5 2YJ, http://www.stmichaels.ac.uk/welcome. Coffee avaiable from 10.30am.

We are delighted to welcome Isaak Hudson to give the 2017 annual lecture. Isaak is a director of Bristol-based DHV Architecural practice and is the architect for Llandaff Cathedral. His talk will outline the project planned for the clerestory stonework at Llandaff, but will also take in his experience as architect for Salisbury and Turo cathedrals.

After lunch in Llandaff there will be an informal, short excursion in Llandaff. Please notify the Secretary (Jana Horak, jana.horak@museumwales.ac.uk) if you will be attending the AGM. Guests are welcome to the annual lecture,but again please notify the Secretary as places are limited. We will confirm the plans for the afternoon to those indicating they are attending.

May 6th: Nolton Haven & St David's

Leaders: Tim Palmer & Robin Sheldrake

Meet: 11.00am Nolton Haven Church, (SM 860 186, post code SA62 3NH).

The senior mason will show us the work that is being done at Nolton Haven church and some of the techniques that are being used. We will then drive on to St David's for lunch at c. 13.30. Cathedral and/or Bishops palace will be visited in the afternoon to examine a range of English and Welsh stone used in the cathedral monuments and font.

June 10th: St Maughans, Abbey Dore, Grosmont, Kilpeck

Leader: John Davies

Meet: 11.00am, abbey entrance Abbey Dore, (SO387304, post code HR2 0AA)

The St Maughan's Formation of Breconshire, Herefordshire and Gwent includes sandstones which can be carved with great detail. This gave rise to a distinctive school of architecture in south-western Herefordshire based around the church of Kilpeck. Examination of buildings in the area has given a clue to varieties of this formation otherwise difficult to detect due to the shortage of rock outcrops.

July 8th: Vale of Glamorgan

Leader: John Davies & Andrew Haycock

Meet: 11.00 am Plymouth Arms car park, St Fagans, (ST 121 722, post code CF5 6DU)

Churches in the Vale of Glamorgan west of Cardiff, and in the Ely valley display a great variety of building stones reflecting the local geology. We will examine these and compare with the dressings, which are exotic to the area. Examination of the Vale of Glamorgan building stone will be continued next year

September 16th & 17th: Llangollen-Wrexham-Ruabon Areas

Leaders: Andrew Hayockc & David Roberts

Meet: Saturday 16th 10.30 a Car park Valle Crucis Abbey, Llangollen, (SJ 2042 4414, post code: LL20 8DD). Sunday 17th: 10.00 am , St Mary's Church, Ruabon (SJ 3028 4380, post code LL14 6DS). Limited parking at church, alternative parking at Ruabon Railway Station.

This trip will take a detailed look at the Cefn y fedw, Gwespyr, Cefn, Coed yr Allt (Halesowen Formation) and Erbistock (Salop Formation) sandstones of the Wrexham and Llangollen region. We will both revisit localities included previously on WSF trips, and visit a number of new localities. The weekend will challenge our ability to identify the sandstones in buildings and the field, documenting their use from the 9th Century (Pillar of Eiseg, Llandysilio yn Iâl), 13th C (Valle Crucis) though to 19th/20th Century and present day. There will be suitable opportunities for lunch on both days. Details of lunch and accommodation in the area to those indicated an interets in this meeting

October 7th: Kidwelly
Leaders: John Davies, Jana Horak & John Shipton
Meet: 11.00am, castle gates (SN 408 070. post code SA17 5BQ). Note this locality is accessible by train.

We will investigate the variety of stone in the castle, gatehouse and priory church. This includes both local Carboniferous stones and more exotic dressings. We will show how stone use changed through the expansion of the castle, informed by ongoing research by Dr Rick Turner. Lunch will be taken in a local hostelry.

The Forum holds indenmity insurance for its field meetings. It would help logistics and paperwork if you could inform the Field Secretary (Michael Statham) if you plan to attend any of the meetings. You will be asked to sign the attendance list on the day.

Bull Cliff Marble

Mike Statham

In the South Wales Daily News of 2nd November 1898, p.4, the following brief article under the general heading of Welsh Gossip appeared:-

> *The Vale of Glamorgan is entirely upon Lias, which affords excellent material for building purposes both in stones and mortar or cement. Barry stone is locally known as Bull-cliff marble, and the Sutton stone is far-famed, ...*

Nobody seems to have heard of Bull-cliff marble but of course the tabular limestones of the Bull Cliff Unit of the Lower Jurassic, Blue Lias Formation strata exposed, for instance, in the sea cliffs around Barry and Lavernock will be well known to geologists. The above reference indicates that these limestones have been locally worked for decorative stone. A tantalising reference to this has been found in Glimpses of Welsh Life and Character by Marie Trevelyn, 1893, p331-2:

> *Some years before his death Mr W put up for himself, on the front of the parish church, a monument of Bull-cliff marble-Barry stone. The inscription was inserted, with the distance mentioned to the grave where he was afterwards interred. The date of his death and age were omitted until after his decease.*

It would be interesting to locate this monument. However, there are few clues as to the identity of Mr W other than that he was a member of a county family, that he was known locally as Billy W and was very eccentric. There is also no clue as to the specific location of the parish church mentioned. Orrin (1988) mentions a "Bull Clifft" monument to three children of the Spickett family who died in the late C18th located in Cadoxton juxta Barry parish church. This church also contains two other monuments made of Bull Cliff marble.

The spelling of Clifft lead to the discovery of another reference referring to a ledger monument in "the east part of the north aisle" of St Andrews Major church, where lie buried John Gibson James (d1601 aged 99) and his wife Margaret Matthew(d1639 aged 124) (ref. Cardiff Nats). Unfortunately this monument is now under carpet but on the wall of the church above, is a monument made of polished Bull Cliff marble. The porch contains another memorial in Bull Cliff marble that is badly weathered but appears to commemorate Margaret (wife) of John, the rest being illegible (so it's not Billy W!).

Several other churches in the Vale of Glamorgan have now been found to contain examples of similar material used as ledger or wall monuments including Porthkerry, Merthyr Dyfan, St Brides Major and Penmark. At Penmark there is also a badly weathered wall tablet on the exterior of the porch, which could possibly be that of Billy W, though this is unproven as the inscription is mostly illegible. Further research is under way.

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Halkyn Marble of Flintshire

Andrew Haycock

Halkyn Marble is a very distinct, crinoid-rich, limestone of Carboniferous age from the Halkyn Mountain region of north Wales. Capable of a high polish, it was worked as an ornamental stone for a wide variety of objects including church fonts, steps, mantelpieces, and pillars from the C19th to mid C20th. Use of the stone continues today, with a local north Wales stone mason recently acquiring a supply of the stone for ornamental work (details below).

Halkyn Mountain has a long historic association with lead and zinc mining as well as limestone and chert quarrying. Much of the area is still owned by the Duke of Westminster / Grosvenor Estate, and the whole region is peppered with disused mines and quarries. Today, several large Tarmac and Cemex owned quarries are still in operation in the area. Despite the years of industrial exploitation the area is still beautiful and popular with walkers, cyclists and cavers.

Geology, quarrying and historic use

Halkyn Marble is derived from near Pant-y-Pwll-Dwr on Halkyn Mountain, in beds of varying thickness (Ellis 1998). Wedd and King (1924) in their memoir for the area note 'crinoidal limestone, capable of a high polish and known as Halkyn Marble has been worked on the top of the hill above Halkyn Hall, where it occurs in large slabs of convenient thickness for mantle-pieces etc. The beds vary from 3 inches to 1 foot in thickness. Their surfaces are dressed with a chisel, and rubbed smooth with gritstones and sandstones of varying coarseness. The polishing is commenced with slate and pumices, and completed with putty powder. The marble has been used in Halkyn Church.'

The Halkyn Marble quarry (SJ 190 720) is clearly labelled on the old Ordnance Survey Flintshire IX. NW, six inch to one mile map of 1900, but has now been completely enveloped by the larger Pant-y-Pwll-Dwr quarry currently owned and operated by Cemex.

The geological memoir by Strahan (1890) notes the 'encrinitol limestone occupying about the same horizon occurs again north of the quarry, and ranges towards Bryn Sannon, but much of it was rendered unfit for polishing by the silicification of the organisms'. These limestones, and those of Pant-y-Pwll-Dwr, were part of the 'White and Upper Grey Limestones' in the old geological memoirs (Strahan / Wedd & King). These are now classified as the Loggerheads Limestone Formation by the British Geological Survey (BGS) and are of 'Asbian Substage age (337.5 to 333 million years old). They consist of thickly bedded, massive, pale grey, shelly limestones (packstones and grainstones), that are locally mottled and pseudobrecciated and are arranged in shoaling upwards cycles capped by calcretes, hummocky palaeokarstic surfaces and associated thin bentonitic clay seams (palaeosols) and rare coals. They are locally dolomitised and contain scattered chert nodules (BGS Lexicon 2016). Davies et al. (2004) report that 'coarsely crinoidal limestones are common in cycles in the upper parts of the formation'.

Halkyn Church

An examination of examples of the worked Halkyn Marble at St Marys Church was undertaken in Spring 2016. The history section on the church's website (see link below) and additional information provided by the Rector's Warden, John Jones, provides some very useful historical insights.

The church, designed by the renowned Chester architect John Douglas, was built in 1877-78 of local Gwespyr Sandstone and paid for by the First Duke of Westminster who at the time owned Halkyn Castle. He had the nearby old church demolished as it had fallen into disrepair and was held to spoil his view. The present church is Grade I listed and considered to be a Victorian gem.

Inside the church, Halkyn Marble has been used to stunning effect in the font, pulpit footing, pillars and parts of the wall at the chancel steps (Fig. 1). The polished limestone is incredibly rich in crinoid material, ossicles and stems (stacks of ossicles). Due to the random arrangement of the crinoid material throughout rock, the polished surfaces of the ornamental stone reveal stems and ossicles in various orientations (Fig. 2). Also present throughout the limestone are large Productid brachiopods (possibly Daviesiella llangollensis?) which is typical to the area. This polished stone was mistakenly identified as granite in the Clwyd Pevsner Architectural Guide (Hubbard 1986).

Bryn Blewog and Pant-y-Pwll-Dwr Quarries

The church visit was followed by a stop at the disused Bryn Blewog quarries, to the north of Pant-y-Pwll-Dwr, to view the crinoidal limestone in field outcrop (Fig. 3). This quarry is located immediately north of

Fig.1 (left). Crinoidal limestone 'Halkyn Marble' font at St Mary's Church, Halkyn (main and inset). Photo: A. Haycock © National Museum of Wales. Fig.2 (right). Detail of 'Halkyn Marble' crinoidal limestone at St Mary's Church, Halkyn. Photo: A. Haycock © National Museum of Wales.

the Babell – Pentre Halkyn road (SJ 18895 72430). Here, large beds (a foot or so thick) can be seen, some beds are jam-packed with crinoid material in various orientations (Fig. 3: Inset – top left). Large Productid brachiopods (like those observed in the stone at the church) were found in association with the crinoids, as well as occasional Spiriferid and Leptagonia brachipods. Weathering of the limestone produces a distinctive texture with the fossil material standing proud of the weathered surface. This may be the result of the partial silicification of the fossil material (as described by Strahan, 1890), as the silicified material would be far less prone to chemical weathering than the un-silicified limestone matrix.

Evidence for historic stone extraction was apparent in the quarry face in the form of partial plug holes, where blocks had been split away from the main face perpendicular to the bedding using the plug and feather method (Fig. 3: Inset – bottom right). Ellis (1998) states 'the earliest reference to quarrying comes in the will of John Salisbury in 1837, in which he left "the marble quarry" to his sons. Nothing is then known till 1859 when Samuel Edwards was granted a twelve-month licence to Bryn Blewog quarry, one of the main sources for the 'marble'. Samuel was followed by his son Edward, who was the master mason responsible for building the new Halkyn

Fig.3: (left) Crinoidal limestone 'Halkyn Marble' at Bryn Blewog quarries (Inset: top left – detail of crinoid fossils, bottom right – evidence of 'plug and feather' work). Photo: A. Haycock © National Museum of Wales. Fig.4 (above). The font at Holy Trinity Church, Watermoor, Cirencester (main and inset). Photo: ©Tony Clack.

church, and who owned and operated the quarry at Pant-y-Pwll-Dwr. The Edwards family remained as owners up to the middle of the C20th. The marble was in demand for items such as fireplaces, but the most renowned use was for the pillars in the new Halkyn church. A block twenty foot square was taken to the Grosvenor residence at Eaton Hall near Chester in 1891 to serve as the plinth for the Eaton Obelisk'.

Gwyn Davies, a stone mason (of G.D. Stonemasons, Rhes-y-Cae), working in the Halkyn area recalls the Bryn Blewog quarry as a child. 'Although disused, and in use as a tip at the time, huge blocks of Halkyn Marble were evident. The quarry face may have been as high as 120 ft (36m) in the past. (Gwyn Davies 2017, pers. comm. 10 January). Today only the top 6 - 10 ft. (2-3m) of the quarry is exposed. It is satisfying to report that he was recently able to acquire 100 tons of Halkyn Marble from the working Cemex Quarry at Pant-y-Pwll-Dwr. He describes one crinoidal limestone bed as being up to 10 ft. thick. The stone he acquired has been used subsequently for various ornamental work, including bathrooms, fireplaces, and decorative work for one of the Birmingham cathedrals. This stone is readily available for any stone matching and conservation work where Halkyn Marble has been used previously.

Gwyn also sent a ceremonial block of Halkyn Marble to Chepstow in 2011 for the official opening of the Wales Coast Path. The path starts near the Old Town Bridge and finishes 850 miles (1, 370 km) away at Queensferry in the north. Two stones bearing the coast path logo mark the official start point. One is of local Pennant Sandstone donated by Forest of Dean Stone Firms Ltd and its partner is a piece of Halkyn Marble donated by Cemex and Flintshire County Council (Chepstow Town Cryer Sept 2011)

A Black Limestone

A dark coloured black limestone with sparser and smaller crinoid material and broken shell fragments has been used to good effect, along with Halkyn Marble, for the font base and columns at St Mary's Church (Fig. 1: inset). It is very likely that this stone was quarried locally around the same time the Halkyn Marble quarries were worked, though this is yet to be substantiated.

Gwyn Davies was able to acquire a black limestone, rich in clay and chert, from the Dependable Concrete Aberdo (Waen-brodlas) Quarry. Here the limestone outcrops in thin bands, and although very hard, polishes beautifully. It was used for decorative work in the Bank of England, London, around five years ago. Gwyn also informed me that this limestone can also be found in a thin band at the top of the Pant-y-Pwll-Dwr Quarry.

A black limestone was historically used in the production of hydraulic cement, and was known as 'Aberdo Limestone' and 'Black Limestone' in the Strahan (1890) and Wedd & King (1924) geological memoirs. These beds now fall within the Cefn Mawr Limestone Formation and Davies et al. (2004) report that 'the Waen-brodlas Quarry (SJ 1875 7313), exposes the upper part of the formation. The dark, tabular-bedded, fine-grained wackestone with mudstone partings, which form the lower part of the section, constitute the 'black limestone' of the previous survey (Strahan 1890)'. Further investigation will seek to establish whether this black limestone, and the one seen at the church, are the same stone.

Historic dispersal of Halkyn Marble

Being so highly prized for decorative work, and the fact that it was extracted from the Duke of Westminster / Grosvenor Estate, leads to speculation that Halkyn Marble may well have been used much further afield than northeast Wales and the Eaton Hall residence.

A chance find on Twitter, tweeted by @buildingstones, Hereford and Worcester Earth Heritage Trust, revealed images of a font at Holy Trinity Church, Watermoor, Cirencester. While similar Carboniferous age crinoidal limestones, like those from Derbyshire and Yorkshire, cannot immediately be discounted the limestone in this font does look remarkably similar to the Halkyn Marble seen at St Marys. (Fig. 4. main and inset). In telephone conversations with Howard Gilbert (the vicar) and Peter Cottey (the church warden), as well as Tony Clack who wrote about the history of the church, I was able to build up some more details about the font.

The church was designed and supervised in construction by Sir George Gilbert Scott 1847 -51 and has two fonts. The older (described as Caen Stone with Derbyshire Marble pillars, 1887, and designed by Scott) sits at the rear of the church and had a brass lid that was raised and lowered by a block and tackle. At some time, the block and tackle broke, damaging the church, and the font has not been used since. A new font was gifted to the parish from St Asaph, by the Rev. J Stephens in 1972. This was destined for nearby St. Lawrence's church but as this was

not yet consecrated, and Holy Trinity was without a working font, it was sent there instead. The font was consecrated by the Bishop of Llandaff. In the inventory provided by the church warden, the new font was described as Derbyshire Marble. I believe this stone may have been identified in error (possibly due to similarities with the Derbyshire Marble pillars on the old font). I have yet to establish which church the new font previously came from but would suggest that as it came from the St Asaph area, it is more likely to be made of Halkyn than Derbyshire Marble. St Marys Church, Halkyn, falls within the Diocese of St. Asaph, and Halkyn is only 14 miles from St Asaph.

Further work

Future research will look at the lithology and fossil assemblages seen in polished examples of the Halkyn Marble and Black Limestone at St Marys Church, and compare them to outcrops in the field, historic samples in the National Museum of Wales collection, and samples to be supplied by G.D. Stonemasons. It is hoped that comparison of these stones with other similar Carboniferous age crinoidal limestones (e.g. Dent Marble, Cumbria; Derby Fossil Marble, Derbyshire and Swale Dale Fossil, Yorkshire) will enable the Halkyn Marble to be readily distinguishable from the others. This will help establish whether the font at Holy Trinity is also Halkyn Marble.

A trip is planned to visit Gwyn at G.D. Stonemasons to view the Halkyn and Black Marble this year. It is hoped this visit will help form part of a WSF trip planned for 2018, which will include a visit to St Marys Church and the old Halkyn workings.

Acknowledgements
I would like to thank the Rector's Warden, John Jones, for access to view St Marys Church Halkyn, and am grateful for his valuable information on the history of the church, and for putting me in contact with local stone mason Gwyn Davies (G.D. Stonemasons). To Gwyn, I would like to extend my thanks for his valuable information on the quarrying of Halkyn Marble and its historic and recent use. To Herefordshire and Worcestershire Earth Science Trust, I am very grateful for the tweeted images of the font at Holy Trinity, a discovery I would not have made without them. To Holy Trinity Church Watermoor, Cirencester I am grateful to the vicar, Howard Gilbert, church warden, Peter Cottey, and Tony Clack who wrote up the history of the church. I am also grateful to Tony for supplying images of the font at Holy Trinity. I am grateful to Cindy Howells (AC NMW) for help identifying fossil material within the Halkyn Marble.

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Fonts of the Year, 2017

Tim Palmer

Many of the Forum's field-trips involve a visit to a church of some sort, where usually we look at a font or two. There is nearly always an interesting stone-related story, and almost invariably the font is made of stone. Wooden or lead fonts do occur, but they are very rare. Many fonts are medieval in origin and the period from the C11th to the C15th saw the incorporation of a font into most existing churches. Many of these ancient fonts even survived major Victorian rebuilding, the old font representing continuity between the old church and the new C19th building. Even if an ornate new Victorian gothic font was provided to take on the function of baptism, the old medieval font may survive in the churchyard, the vicarage garden or within a corner of the church. Sometimes it was deliberately broken, and sometimes the pieces were ritually buried within the fabric of the new church.

The stones of these early fonts provide us with several different sorts of information about medieval stone usage. They are usually made of freestone so that they could be carved satisfactorily in all three

dimensions, and thus tell us about which freestones were in local use, and are likely to have been used in local medieval buildings, which may themselves have been robbed out and long disappeared. Some fonts in south and west Wales (particularly close to the coast) are made of stone that was clearly imported into the region over long distances, either from elsewhere in the country or even from England. These stones tell us about medieval trade routes and sometimes about the patronage of the rich and powerful who were involved with the foundation and construction of medieval churches. Rarely, fonts made of the most fashionable and expensive types of stone are pointers to the most important and influential churches of the time. The polishable Purbeck Marble from Dorset, highly desirable from the late C12th to the C14th, was used in only two Welsh foundations of great importance – St David's Cathedral, and St. Padarn's (Llanbadarn Fawr) in northern Ceredigion.

There is a suite of very similar fonts in Carmarthenshire, Pembrokeshire and Ceredigion that has attracted the attention of architectural scholars (e.g. Thurlby, M. 2006. Romanesque Architecture and Sculpture in Wales. 384 pp. Logaston Press). They are referred to as Table-top Fonts and they look like a square or slightly oblong box sitting on a scalloped capital. They are made from a single large cube of stone, Front from Train churcjhwith the horizontal junction between the square bowl and the scalloped capital marked by an incised line around the four sides. They are characteristic of southwest Wales, probably dating from around the end of the C12th. Two of them are illustrated below, and their stonework is exceptionally interesting. Most of them are made of a coarse grey sandstone that lack obvious bedding planes, though some show an oblique plane of weakness rather like the adjacent folds seen in a roll of freshly-kneaded pizza dough. Are these soft sediment deformation features in the original sediment? Fonts of this pattern are seen in a couple of dozen places, from Ystrad Aeron, Tremain, and Munt in Ceredigion, down to Solva in Pembs. The grey quartz sandstone looks similar in many of them and suggests a site of common origin for the stone. But where from? One of the Ordovician sandstones from Pembrokeshire perhaps? We need to know, and all suggestions are welcome. But across the same area of land, from Penbryn (Ceredigion) to Roch (Pembrokeshire) and Oystermouth (Gower), are identical-looking fonts made of pale Dundry Stone from Bristol. Were the sandstone examples the native production and the Dundry versions merely imported imitations, or were the latter made close to the sites of installation, fashioned by local masons from easy-to-work Dundry Stone blocks that were imported from Bristol into southwest Wales for just such a purpose?

Font worked from Dundry Stone, Penbryn, Ceredigion.

Sandstone font from Tremain church.

Southwest Wales Romanesque table-top fonts with square bowls and scalloped capitals. They are either made of course grey sandstone, or of Dundry Stone from Bristol. The geometries are essentially the same in both cases. Upper example: sandstone (of uncertain origin), Tremain, Ceredigion; Lower example: Dundry limestone (from Bristol), Penbryn, Ceredigion.

'Snowdrop Marble' and other 'black marbles' of Pembrokeshire & Ceredigion

Andrew Haycock

During the Forum trip to Tenby in September 2012 (see John Shipton, Tenby, Newsletter 10, 2013), a fossiliferous, Carboniferous-age limestone was seen at the Prince Albert Memorial on Castle Hill. This limestone is rich in brachiopods and corals and was deposited in a warm, shallow, marine environment over 325 million years ago (Ma).

The Albert Memorial was erected in 1865 by George Thomas, a builder from Pembroke. Sicilian marble was used for the ornate statue and coat of arms, but Carboniferous Limestone for the steps and statue plinth in which some of the brachiopods exhibit distinct spiral lophophores. John Davies and Ron Austin informed the group that this particular limestone, local to Pembrokeshire and Carmarthenshire, produced a distinct, dark, ornamental stone when polished. It was known as 'Snowdrop' Marble because the brachiopod fossils, when cross-cut in profile, resemble snowdrop flowers. When polished, the white fossils stand out in stark contrast to the black limestone matrix. The dark colour of the stone made it highly sort for decorative work, particularly for church memorial plaques, mantelpieces and fire surrounds.

Later on the same trip, we saw polished examples in slabs and memorials at St Mary's Church. Some slabs appeared quite rich in productid brachipods, while others were rich in smaller brachiopods, some with a distinct forked spondylium. Since this excursion, similar 'Snowdrop - like' black limestones in ornamental works have been seen on other trips. The most recent (at time of writing) was the Charles Rudhall (d. 1815) wall memorial in the west end of Gloucester Cathedral in October 2016, which "is crowded with brachiopod shells and rugose coral' (Jackson, 2016).

It would be simple if the source for Snowdrop Marble was a single quarry near Tenby which, in the case of the Albert Memorial, is almost certainly the case. This quarry was a little to the north of Marros Cross, Pendine and is described later. However, like most things, it is not always that simple. Research into the literature reveals that a black limestone has been quarried at several localities along the north and south crops of the Carboniferous Limestone in Pembrokeshire and Carmarthenshire, so that telling each limestone apart may be very difficult or impossible. Only by matching the different examples of stone to historical references for a known quarry may we understand its use and dispersal for monument work across Wales and the wider UK.

There are other black fossiliferous limestones of similar age from further afield (e.g. Kilkenny Fossil marble, Ireland) which may be confused with Snowdrop Marble and which have also been used for ornamental work. It is not within the scope of this article to discuss the differences between these, although this will hopefully form the basis for future work in that area. Jackson (2016) on the Rudhall memorial at Gloucester Cathedral notes 'an image was sent to Professor Patrick Wyse Jackson (Trinity College, Dublin) who claims that the brachiopod fauna is different from that of the Kilkenny'.

Geology

Snowdrop Marble is not a true marble (a highly metamorphosed pure limestone), but a dark-coloured oolitic limestone that occurs within the Carboniferous Limestone Supergroup (CLS). Ooliths are tiny spherical to sub-spherical, sand-sized, grains composed of concentric layers of carbonate material, which grow inorganically around a nucleus of another particle. The rock is composed of many of these tiny oolliths and numerous fossil material. The known sources for Snowdrop Marble and (ornamental) black limestones all lie within the Pembroke Limestone Group, a Courceyan to Brigantian age (326 to 359 Ma), (BGS Lexicon 2016) sub-group of the CLS.

The extraction of black limestone 'marble' in Pembrokeshire and Carmarthenshire is controlled by the outcrop of the Carboniferous Limestone Supergroup (CLS). As a product of the structural geology and lateral changes in lithology of this Supergroup, the black limestone may only have been available and economically viable to extract at certain points along the outcrop. While there are many quarries in the CLS, historically, many of these were for worked for lime and aggregate as well as building stone. Today, many of the older quarries have been obliterated by larger-scale modern quarrying ornamental stone quarries may have been completely lost.The CLS outcrops in several bands to the north

Figure 1: Map showing Snowdrop / Black Marble quarries in relation to Carboniferous Limestone

and south of the South Wales Coalfield (Fig. 1). The south crop, in Pembrokeshire, occurs in a band to the south and east of the Cleddau Estuary between Angle, Pembroke and Caldey Island and then in a sweeping band from Pembroke Dock and Lawrenny eastwards to Tenby. It also outcrops on the southern tip of Pembrokeshire around Bosheston. The north crop (Fig. 1) outcrops in a thin band (approximately aligned NW/SE) from Minwear in Pembrokeshire through Templeton to Pendine in Carmarthenshire. From Kidwelly it occupies a SW/ NE trending band towards Crwbin and Carmel, and then continues in a long sweeping arc around the north crop of the South Wales Coalfield.

Known quarries and examples of use

1. Pwll Chwarel (Pwll Quarry), Marros, Pendine

This quarry is the source for the stone used in the Albert Memorial at Tenby and quite possibly also the stone in St Mary's Church. The quarry lies a little to the north of Marros Cross, Carmarthenshire (SN 2109 0947) but is now very overgrown and almost completely in-filled, though some low outcrops at the top of the quarry are still visible. These contain Productids, some unidentified brachiopods and Rugose corals (zaphrentid).

An article by Baker-Jones (1971) about 'The Morris Family of Carmarthenshire', in the Transactions of the Carmarthenshire Antiquarian Society, states 'Tom Morris and his brother Ben, both natives of Pendine, their headstones side by side in Pendine Churchyard, record the death of Thomas Morris, sculptor, of Morfabychan, on February 15, 1886, aged 82, and of Benjamin Morris, of New Inn, Pendine, on February 17, 1885, aged 72. Their skills as monumental masons in the middle years of the 19th century was held in much esteem in all the district round about'. The article goes on to state 'Tom was born in 1804, and went as a servant boy to Messrs, Rogers, marble masons, of Tenby, who amongst other important works, built in 1864 the Prince Consort memorial on Castle Hill. Showing a marked talent for stone engraving the firm took him on as an apprentice, and he remained with them for some years, later returning to Pendine. He considered Pwll Quarry (situated a few hundred yards to the west of Greenbridge) the best for monumental purposes, and here he found his favourite ' snow-drop marble,' which when polished has a lustrous black surface flecked with white shells,

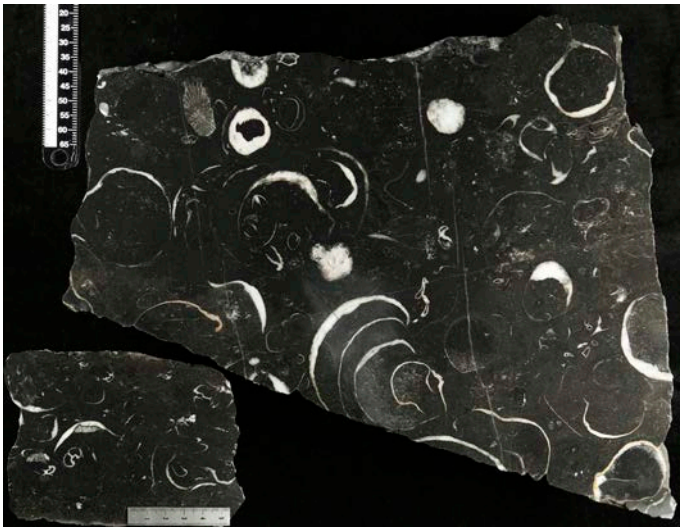

*Fig. 2: (top left) Example of dark limestone from Carew Newton quarries**, inset: bottom left – second variety of stone**, inset: bottom right – detail of mantelpiece surround, Tenby (Tim Palmer), (**Acknowledgement to Sedgewick Museum, Cambridge). Fig 3: (bottom right) Fossil material in outcrop, Llangynderyn quarry. Inset: Fresh outcrop in area of fallen tree. Image: A. Haycock © National Museum of Wales.*
Fig 4 (top right). Polished slab of limestone from Llangynderyn quarry. Image: A. Haycock © National Museum of Wales.
Fig 5 (bottom left). Charles Rudhall memorial plaque, Gloucester Cathedral. Image: A. Haycock © National Museum of Wales.

which to old Tom's eyes had the appearance of ' snow-drops.' In Pwll Quarry he found most of the stones for his monuments, and also for mantelpieces, slabs, tables, and other domestic purposes. It was from this quarry that stone was taken for the Prince Consort's Memorial at Tenby'.

We cannot conclude for certain that the Snowdrop Marble seen at St Mary's Church was derived from Pwll Quarry, without the evidence to prove it. One ornamental slab at the church, with a range of dates of death from 1788 through to the 1820s, would suggest that black limestone was being used long before it became a favourite of Tom Morris. This slab was rich in productid brachiopods and fragments of smaller unidentified brachiopods with a distinct forked spondylium. Another slab dated 1811 was dominated by productid brachiopods. Other slabs were sparse in productids, but rich in smaller brachiopods with

a forked spondylium. This would suggest there is some local variation between the beds either within the same quarry or from different quarries. Memorial slabs were produced at different times, and therefore may not have all come from the same source or even horizon within the same quarry.

2. *Carew Newton Quarries, Pembrokeshire*

The quarries at Carew Newton *(SN 047 044)* lie within the Pembroke Limestone Group, the same group from which stone was extracted at Pwll Quarry to the north east. There are specimens of polished black limestone in the J. Watson building and ornamental stone collection held at the Sedgewick Museum, Cambridge. Watson (1916) notes 'the Lower Carboniferous series in South Wales furnishes beds of a compact highly fossiliferous limestone. It is blue-grey in colour, with prominent white markings due to the fossils, nearly all of which are Brachiopods, mainly belonging to the genus Spirifer. The specimen from Carew Newton Quarries is a good example of this stone, which, when polished makes a useful marble. It is used locally for monument work and making mantelpieces' (Fig. 2 main image). He goes on to note 'a second variety of the marble which has just been described (Fig.2 inset: bottom left). The matrix of this stone is considerably darker than in the former example, and the fossil Brachiopods are much less abundant. A few corals appear in the specimen'. Carew Newton is nearly 3 miles closer to Tenby than Marros Cross so it is reasonable to conclude that this quarry is quite likely to have provided some of the stone for monumental work in the Tenby area. A fire surround seen by Tim Palmer at a private house on St Julian's Street, Tenby, looks very similar to the ornamental stone in the Sedgewick Museum collection and is crowded with brachiopods, some with a forked spondylium, as well as rugose corals (Fig. 2 inset: bottom right).

3. *Laswern, Felindref, Llangynderyn*

This quarry (SN 46478 12426), near Crwbin, is quite well documented. Strahan (1909) notes 'a black oolite limestone has been quarried for 'marble' at Laswern near Felindref'. Lloyd (2006) notes 'one site near Llangynderyn produced a black marble that could be polished, and used for chimneypieces and memorials'. Although overgrown, some good outcrops still occur. At the time of my visit (March 2014), a tree had fallen from the cliff face revealing some fresh outcrop (Fig. 3) containing numerous brachiopod material and zaphrentid corals. A specimen, from the National Museum of Wales collection, was cut and polished and revealed more of the fossil material which consisted of zaphrentid corals and rhynchonellid and productid brachiopods (Fig.4).

A notice in the *Cardiff and Merthyr Guardian* 12 Oct 1833, documents to the potential letting of a marble quarry at Llangynderyn (Llandeirne). The notice explains 'the celebrated BLACK and BLACK AND WHITE marble quarry. The produce of this quarry, which is now proposed to reopen, was, until of late, well known in the London and other markets by the name of Welsh Black, and was renowned for the purity, lustre and size of its blocks'. The article goes on to state that specimens could be seen by contacting one of several addresses in London. There was evidently a good market for this high quality Welsh stone in the early C 19th in London, and there is the possibility that examples have survived. Archival research will hopefully throw some light on the right places to look in the future.

4. Tyrgarn Farm Quarry, Llanddarog

A notice in the South Wales Daily News of 15th June 1899 highlights the sale of Ty'r Garn Farm. It notes 'there is on the property a most valuable BLACK MARBLE QUARRY, also a limestone quarry, and two lime kilns'. Several disused quarries can be found around SN 5021 1424 which lie on the same crop of the Pembroke Limestone Group as those previously described. I hope that further research will produce evidence of ornamental stone from this quarry.

'Snowdrop' or Black Marble?

Stone from Pwll Quarry was evidently called Snowdrop Marble by the mason Tom Morris, and quite possibly by other masons who worked the same stone before him. The name 'Snowdrop Marble' seems to have lived on till the present day to describe other similar Carboniferous age, black and white, brachiopod-rich, fossiliferous limestones from the region.

References suggest that stone from the Llangynderyn and Llanddarog quarries were marketed as 'Welsh Black', 'Black' or 'Black and White' Marble although it cannot be guaranteed that stone from these and other quarries were not also potentially marketed as 'Snowdrop Marble' at some time in the past. The name has a ring to it, and the marble might have sold better as a result. For example, a notice in the Gloucester Journal for 13th May 1848 advertises marble and other stone from William Bussell's Marble Works near Gloucester Station. 'For sale at reduced

prices. A large variety of foreign and other chimney pieces, consisting of Statuary, Black and Gold Dove, St Ann's Vein, Black and Snowdrop Marbles'. There is no mention of a 'Black and White' marble in this advertisement and the notice would suggest that it was possible that the 'Black and White' fossilised variety may have been sold as Snowdrop Marble. This would be difficult to confirm as would which quarry the stone came from once it left the mason's yard as 'Snowdrop Marble'.

Gloucester Cathedral

Several examples of 'Snowdrop' can be seen at Gloucester Cathedral. The wall tablet memorial plaque to Charles Rudhall is crowded with brachiopod shells (with forked spondylium) and rugose coral (Fig. 5). This stone can be compared to examples seen at Tenby, Llangynderyn and Carew Newton and although there are similarities between them, it is currently very difficult to assign the stone to a particular quarry.

Fossil fauna

Colleagues at the National Museum have examined images from Carew Newton quarry, Gloucester Cathedral, Tenby and Llangynderyn quarry, and confirm the presence of the brachiopods Productida sp., Rhynchonella sp. and *Spirifer sp. in the stone. Full identification is difficult on the basis of only partial, cross-cut shells to go on. Leonid Popov (Honorary Research Fellow, NMW) suggests that some of the historic references and identifications assigned to the genus Spirifer may actually be the Rhynchonelliform order of the brachiopod Athyridida. Ron Austin (WSF member) considered some the brachiopods (those with spiral lophophores) seen at the Albert Memorial, Tenby to belong to the genus *Seminula.* Lucy McCobb (pers. comm. 16 Feb) notes that *Seminula* has now been reclassified as *Composita*, and some of the fossils were a good match for this identification. The distinct brachiopods with a forked spondylium remain to be identified. Cindy Howells and Lucy McCobb both confirmed the identification of the rugose coral *Zaphrentis* sp.

Future Work

I hope to identify and investigate other Snowdrop Marble sites in the field, as well identify more ornamental works made of this stone. It will be interesting to find out if similar Carboniferous limestones were extracted for ornamental work elsewhere in Wales and the wider UK.

Acknowledgements

My thanks go to Mike Statham for providing reference to notices in the Cardiff and Merthyr Guardian, South Wales Daily News and Gloucester Journal, the result of which has enriched my article. I am very grateful to Dr Dennis Jackson for information on the use of Snowdrop Marble at Gloucester Cathedral, and to Dr Tim Palmer for his knowledge on the stone and for permission to use the image of a mantelpiece surround at Tenby. I am grateful to the Sedgewick Museum, Cambridge, for the use of images of the Carew Newton specimens in the Watson Collection and to Leonid Popov, Cindy Howells, Lucy McCobb, Tim Palmer and Ron Austin, for help in identifying the fossil specimens. Thanks to Amanda Valentine – Baars for preparing a specimen from the collection in the laboratory.

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Building stones in churches across Wales: a national map of vernaculars: Part 4 – Ceredigion and Pembrokeshire

John Davies

The survey of building stones of the churches in the counties of Wales has been completed for Breconshire, Radnorshire, Montgomeryshire, Carmarthenshire, Ynys Mon [Anglesey] and Meirionydd, with data published in the Welsh Stone Forum *Newsletter* Nos.11, 12, & 13. This fourth part of the work presents maps for the churches of Ceredigion and Pembrokeshire.

Technique

The method employed during the survey of churches in previous counties has been continued in this study. As this has been fully described in the previous parts published in the Newsletter is not repeated here

Ceredigion

Across the county different stones for use as dressings were available. These form distinct areas on the county map although exotic dressings, imported from outside of the county, are particularly common, especially from the C19th onwards. These mostly consist of Triassic sandstones and Jurassic 'Cotswold' Limestones but also Namurian sandstones, from Flintshire, many of which were possibly imported by sea or railway. The county is generally underlain by sedimentary rocks of Ordovician and Silurian age, which yield mainly sandstones and cleaved-mudstones that form the predominent building stones used. These are:

Geological Age	Stratigraphic Unit	Rock Type
Silurian	Cwmystwyth Grits Group	Hard, blue-grey turbidite sandstones
	Aberystwyth Grits Group	Hard, blue-grey turbidite sandstones Cleaved mudstones
Ordovician	Caradoc-Ashgill sandstones	Yellowish sandstones Cleaved mudstones

Table 1. Summary of the Ordovician to Silurian sequence in Creredigion.

Ordovician

These rocks occur in three areas where they exhibit very similar lithological characters:

1. Machynlleth Inlier
2. Pumlimon Inlier
3. South of the county including the Teifi Anticline (extending into Pembrokeshire)

The rocks in the Machynlleth Inlier belong to the Upper Ordovician, Ashgill Stage and consist of fining-upwards cycles, changing from massive hard sandstones to alternating hard sandstones and mudstones, and then siltstones and mudstones and finally, to mudstones. They are generally cleaved and the mudstones are locally slaty. These were of little use for building except for rubble-walling, and the siltstones were generally rendered to protect them from weathering.

The Pumlimon Inlier contains the older Ashgill age Nant-y-Moch Formation, which is dominated by more massive sandstones. These occur in an area of very low population and were generally not exploited for building.

The main Ordovician outcrop occurs south of a line from Llangranog in the west, to near Llanwnnen, in the Teifi Valley and then across the Teifi into Carmarthenshire at Llanfiangel ar arth. Southwest of this line, the sandstones are the closest to a freestone that occurs anywhere in the county and have been used as such in this area. The outcrop continues into north Pembrokeshire. These rocks consist of yellowish, massive sandstones with a weak cement, which enables them to be dressed and they have been marketed in the area as 'Pwntan Stone' [Palmer, 2010, Davies & Palmer, 2013).

Silurian

Only the lower two divisions of the Silurian, the Llandovery and Wenlock Series, occur in the county which surrounds the Ordovician inliers, and occupy the largest area of ground within the county. The succession consists of a number of hard sandstone sequences of different ages in different parts of the county. The oldest beds belong to the Cwmere Formation (Lower and Middle Llandovery), that consists of cleaved mudstones. These are succeeded by the sandstone-dominated Devil's Bridge Formation (Upper Llandovery), which in turn is succeeded by the Aberystwyth Grit Group and then the Cwmystwyth Group. Each of these these has an area where they reach their maximum thickness - in the Aberystwyth Grits this is along the coast from east to west; in the Devil's Bridge Formation in the centre and the Cwmystwyth Grits [Llanddewi Bluestone] in the Cambrian Mountains [Elenydd]. The sandstones are dominatly strongly graded with a silica cement, which gives them great strength and makes them ideal for rubble walling but also makes them difficult to dress.

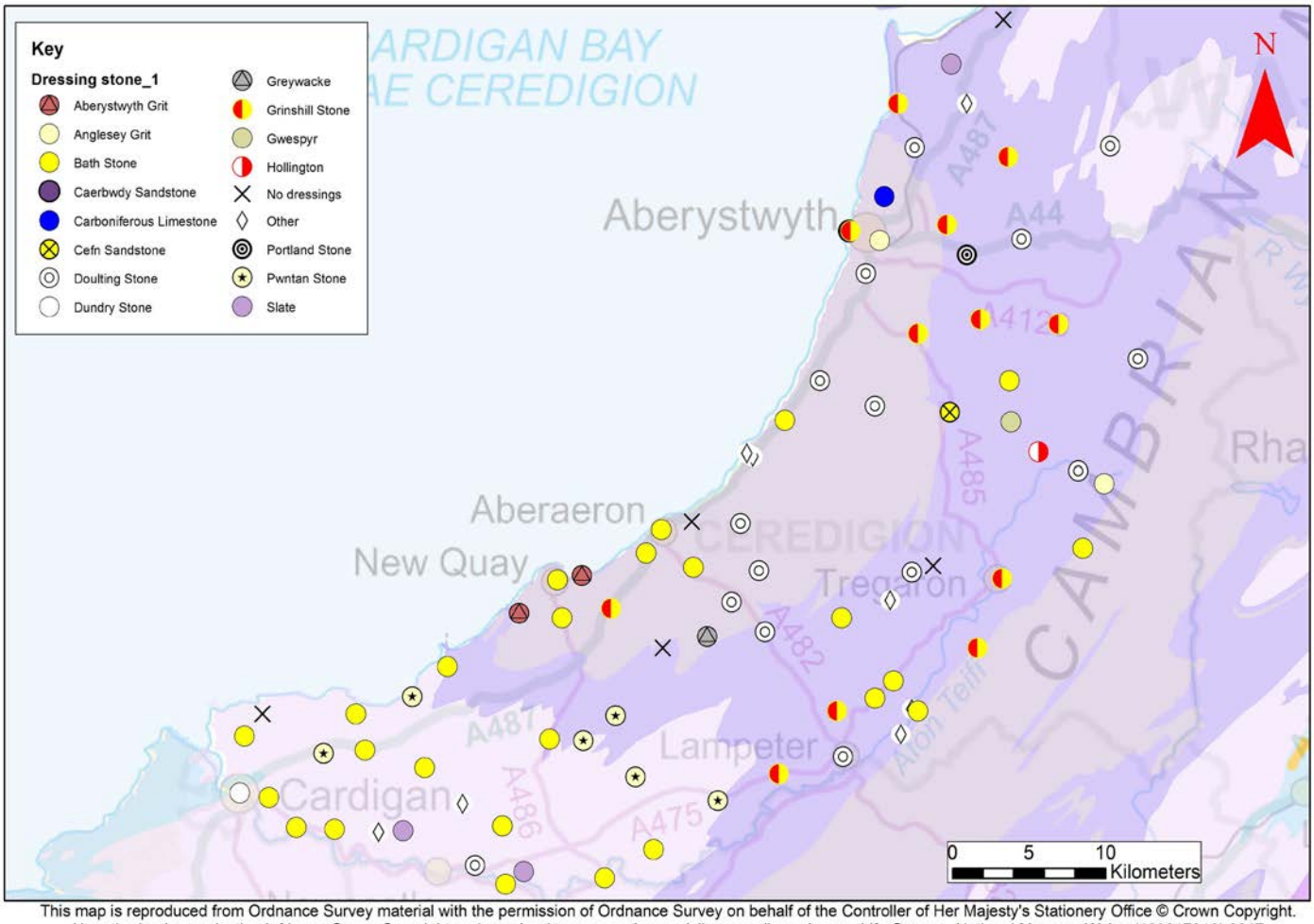
Other stones

Due to the lack of any indigenus freestones a large proportion of the dressings in this county are imported stone. These consist of Bath Stone (28 of 94 sites sampled), Doulting Stone (19/94), Dundry Stone (02/94), Grinshill Stone (15/94), Cefn Sandstone, (03/94) with Anglesey Grit (02/94), Portland Stone (02/94) some red Triassic sandstones (01/94) and Caerbwdi Sandstone (02/94). There are also some concrete dressings and some wooden windows

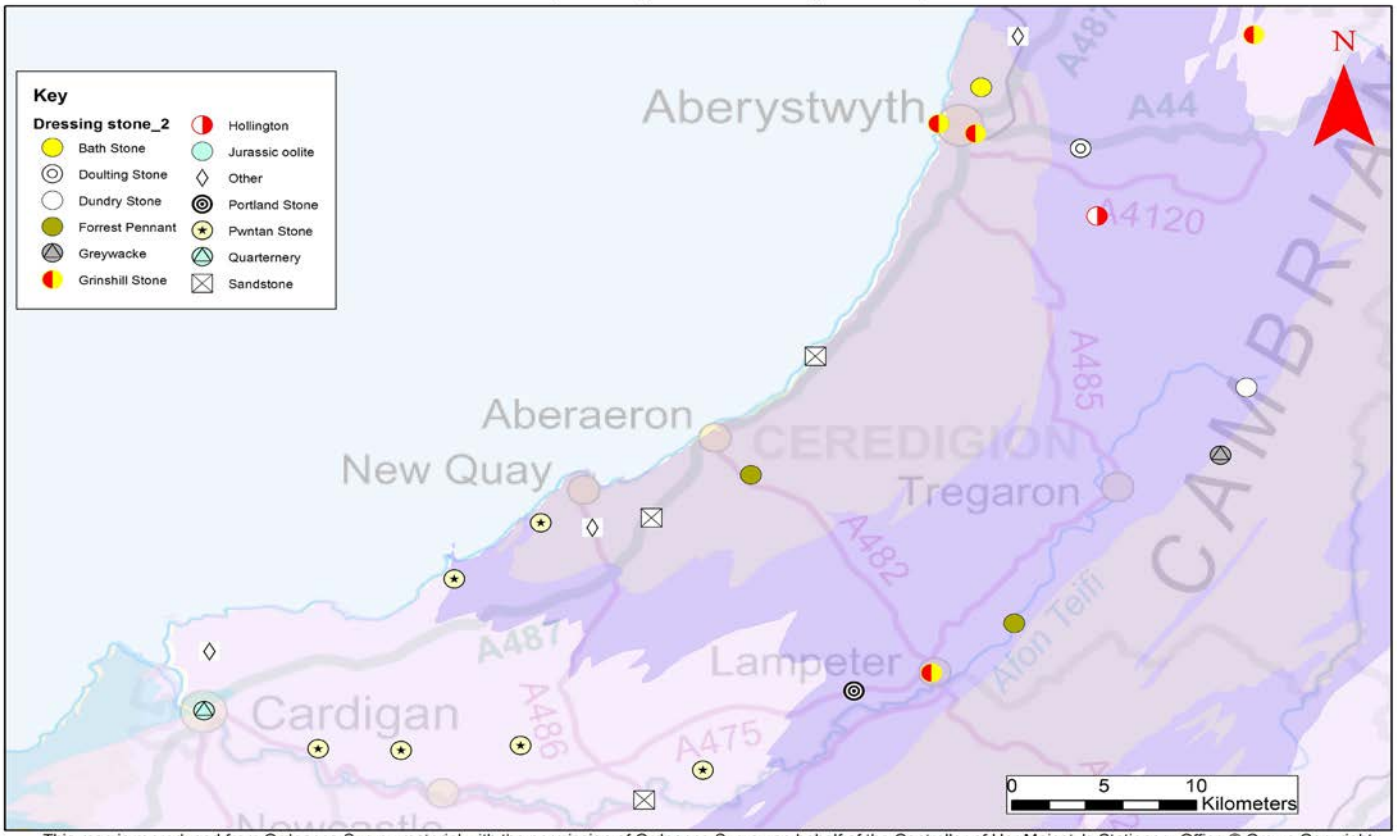
Description of the maps

As with the other counties maps have been used to show the distribution of the dominant dressing stones. Two or more maps have been used to avoid over congestion of data points, but the maps should

Ceredigion - Dressing Stone 1



Ceredigion - Dressing Stone 2



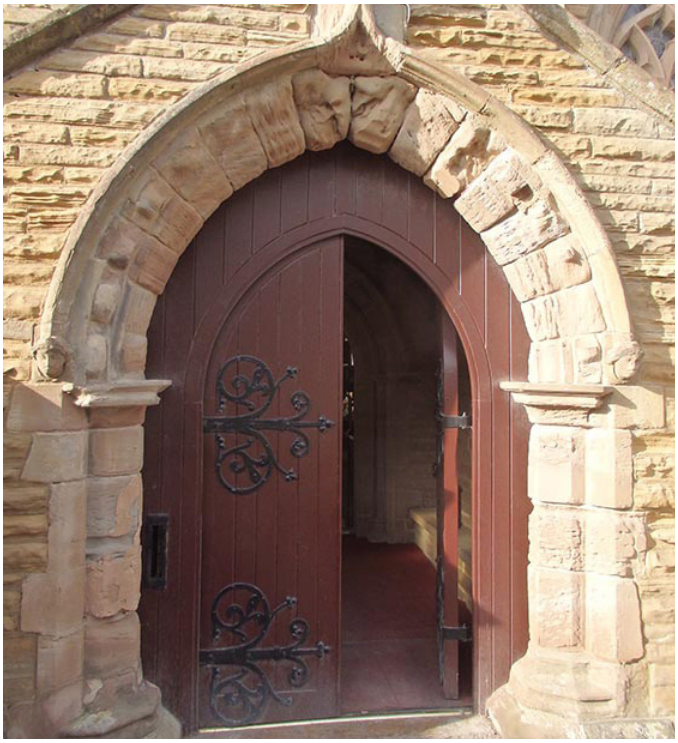
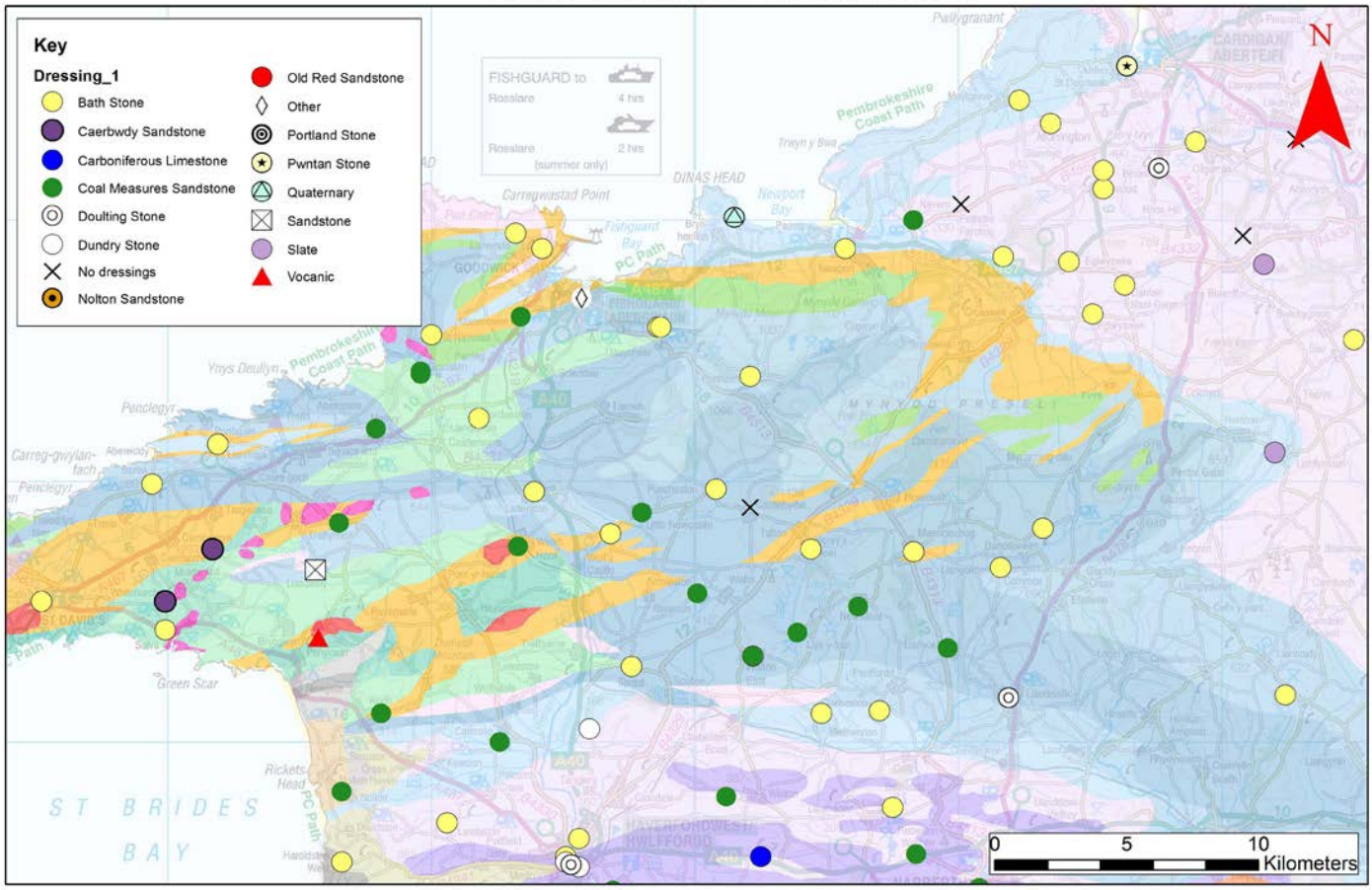


Fig. 1. Grinshill Stone, St Machael's Aberystwyth, Ceredigion. Fig. 2. Aberystwyth Grit, Llanbadarn Fawr, CeredigionFig. 3. Portland Stone, Capel Bangor, Ceredigion. Fig.4. Hollington Stone (?),Ystrad Meurig, Ceredigion. Fig. 5. Bath Stone, Llangynllo, Ceredigion. Fig. 6. Pwntan Stone, Bwlchyraddfa, Pont Sian, Ceredigion.

North Pembrokeshire - Dressing Stone 1



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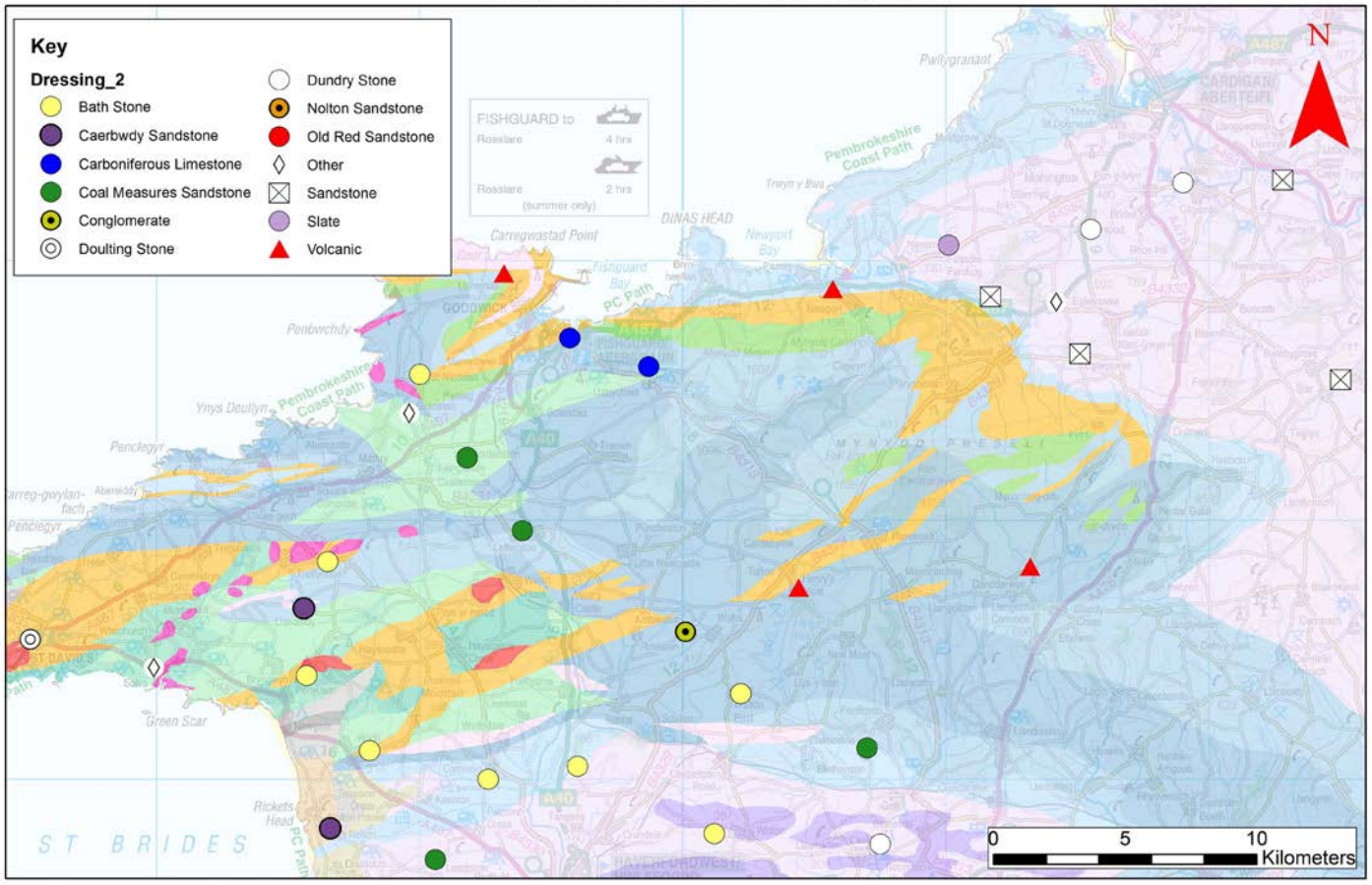


be given equal status and used together. The keys will hopefully be self explanatory. It is hoped that these will provide useful information for understanding how building stones have been transported around Wales over the centuries. Developing a chronology of the use of stone is here left to architectural historians.

Pembrokeshire

There is a large variety of building stones available within the county, which show up as distinct areas on the maps. Exotic, imported dressings are particularly common, especially from the C19th onwards. These consist mostly of varieties of Jurassic limestones, but also Coal Measures sandstones (some from within the county) and Forest of Dean Pennant Sandstone. However, the geology of Pembrokeshire is extremely varied and includes a wide variety of rocks ranging in age from the Precambrian to the Carboniferous Coal Measures. These are are summarided in Table 2.

Distribution

The county can be easily divided into two by drawing a line from St Brides Bay eastwards to the Whitland area. North of this line the geology of the upper part of the sequence includes the same lithologies as in adjacent Ceredigion. Below these the sequence descends through the Ordovician of the Presely Hills to the Cambrian and ultimately the Precambrian rocks of the St David's peninsular.

Geological Age	Stratigraphic Unit	Rock Type
Carboniferous	South Wales Coal Measures Group	Yellow & yellowish grey sandstones Soft grey sandstones Nolton Haven
	Millstone Grit Group	White, quartz-sandstone
	Carboniferous Limestone Supergroup	Massive pale, and dark grey limestone
Devonian/L Silurain (ORS)	Skrinkle Sandstone Formation	Sandstone
	Ridgeway Conglomerate Fm	Conglomerate & pebbly sandstone
	Conigar Pit Formation	Greenish-grey sandstones
Silurian	Cwmystwyth Grits Group	Hard, blue-grey turbidite sandstones
	Aberystwyth Grits Group	Hard, blue-grey turbidite sandstones Cleaved mudstones
Ordovician	Caradoc-Ashgill sandstones	Yellowish sandstones, locally pebbly Cleaved mudstones
	Llanvirn-Caradoc	Dolerite, spotted dolerite, welded tuffs
Cambrian	Caerbwdy Sandstone Formation	Purple sandstone
Neoproterozoic (Precambrian)	'Dimetian'	Granitic rocks
	Pebidian Supergroup	Purple & sage-green volcanic tuffs

Table 2. A summary of the Carboniferous - Neoproterozoic geology, Fm = Formation, Gp = Group.

N. of the line from St Brides Bay – to Whitland

The Precambrian: Pebidian

The Precambrian volcanic rocks crop out in in two areas across north Pembrokeshire. The northern strip extends from Tregenis Head eastwards through Treffynnon while further southeast another area stretches from the northeastern corner of St Brides Bay, eastwards to Treffgarn. The rocks in both areas consist of purple and sage-green cleaved ashes which were used extensively for rubble walling and even dressings [St David's Cathederal].

The Precambrian: 'Dimetian'

These consist of a suite of intrusive igneous rocks, including the St David's Granophyre. The latter was only of limited use for building around St David's itself.

Cambrian

Cambrian rocks crop out in the cliffs on the north side of St Brides Bay and surround the Precambrian inliers. They include a fining-upward series from conglomerates at the base, through the purple and green Caerbwdy Sandstone to the Lingula Flags. The most useful of these, Caerbwdy Sandstone, was used for dressings in St David's Cathedral and over a large area of the county and even as far north as Strata Florida in Ceredigion.

Ordovician

The lowest Ordovician rocks consist of the Arenig Grits followed by the Llanvirn mudstones, which contain extrusive volcanic rocks, including welded tuffs and pillow-lavas and intrusive sills. The welded-tuffs were used for rubble walling but the pillow lavas were unsuitable. Of greater importance, as building stones, are the intrusive igneous rocks including the dolerites on the northern side of St David's Head, Strumble Head and the Presely Hills. These include the spotted dolerites of the Presely Hills which were used for megalithic and early Christian monuments.

The remainder of the Ordovician, the Caradoc and Ashgill, contains rocks that are very similar to those of the adjacent parts of Ceredigion and Carmarthenshire. These include yellow sandstones similar to the Pwntan Stone. A large area of turbidite sandstones occurs between the Teifi Estuary and Newport Bay. These grey, silica-cemented sandstones, were used locally for rubble walls but are generally too hard to be dressed.

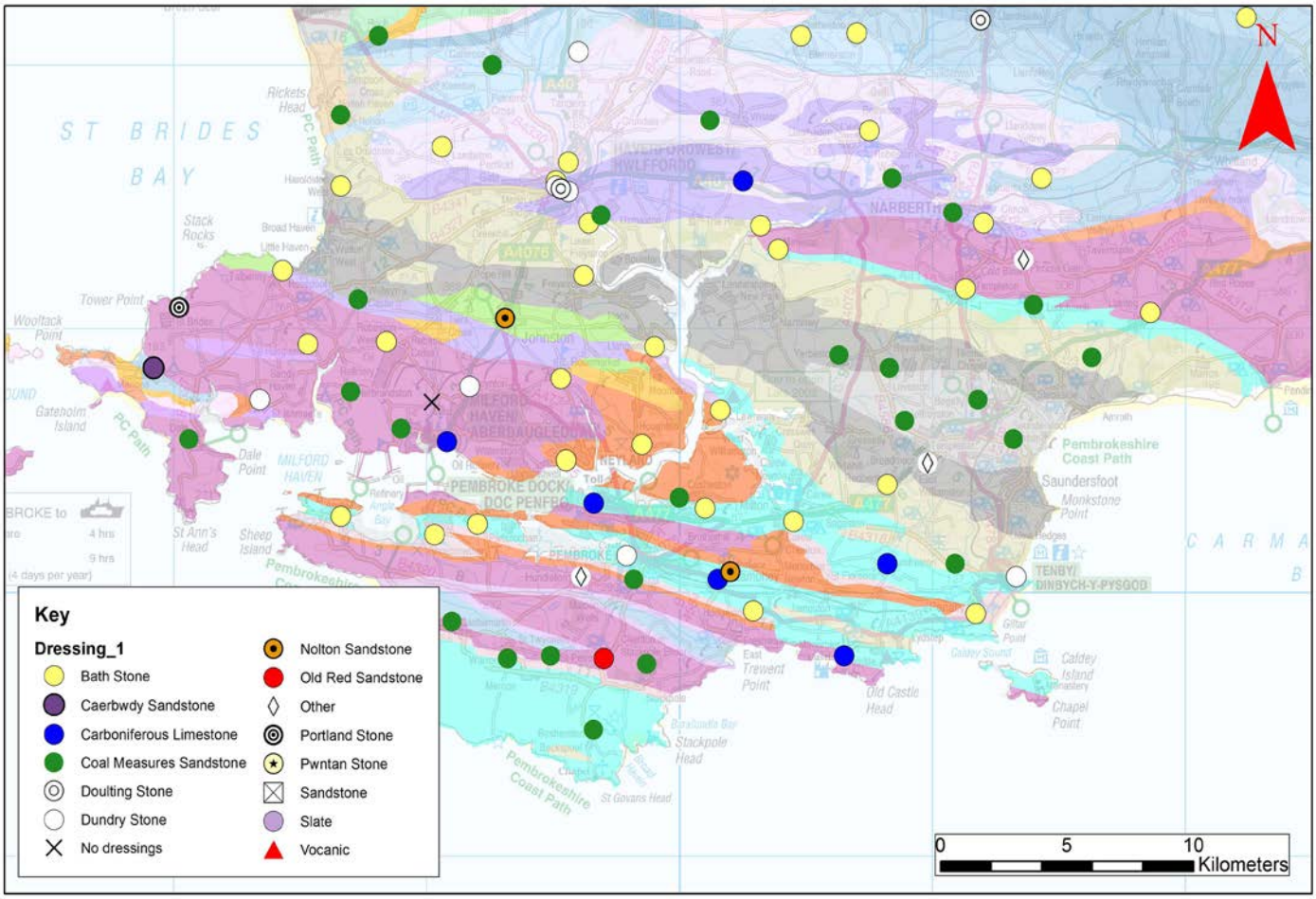
Silurian

Silurian rocks are absent from this area.

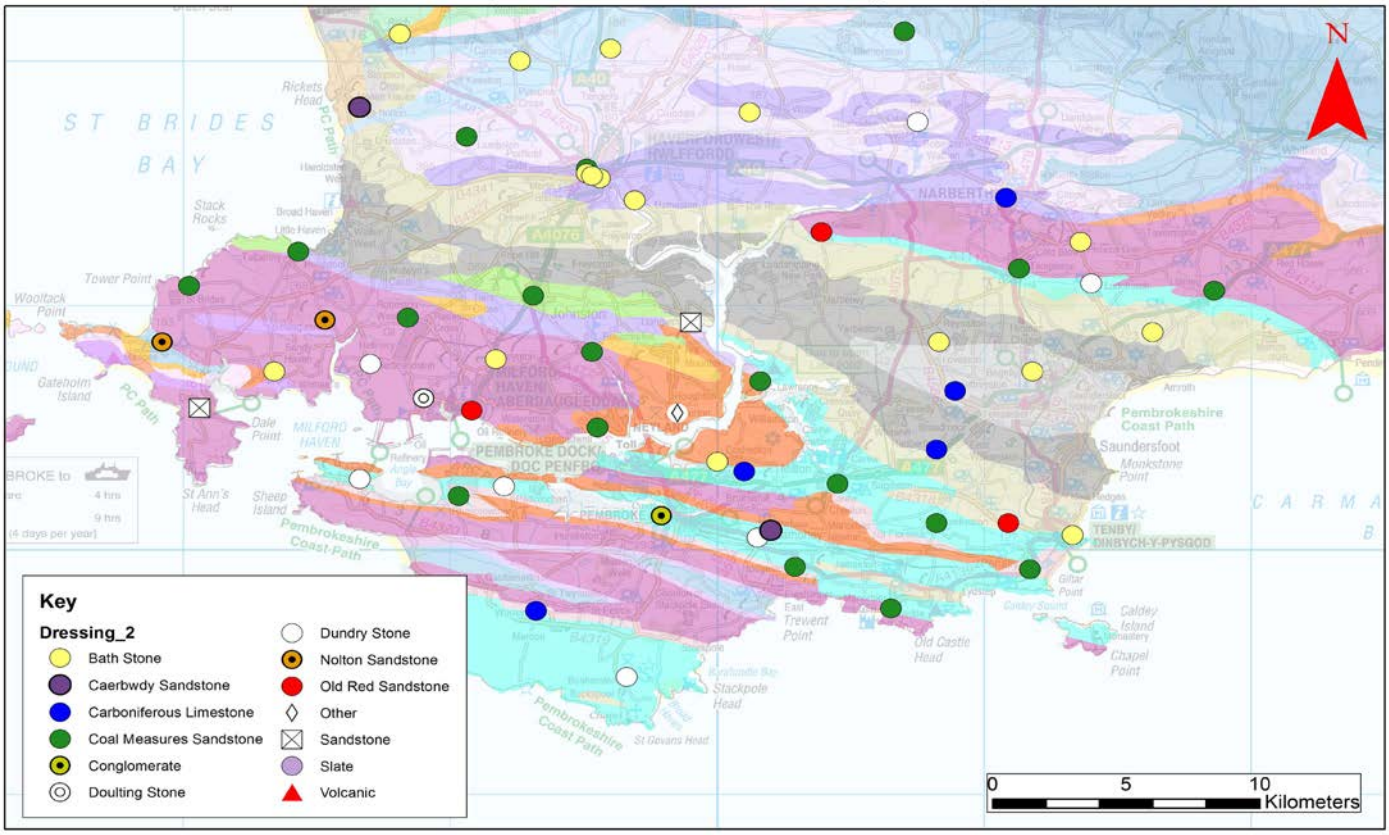
Quaternary

East of Newport Bay there is an extensive outcrop of iron-welded scree of Quaternary age, which were

South Pembrokeshire - Dressing Stone 1



South Pembrokeshire - Dressing Stone 2



used for window dressings and other worked stones in the area as far east as St Dogmeals Abbey. It has not been worked in modern times and it has not been possible to identify the actual workings to date.

Sof the line from St Brides Bay – to Whitland

The various aged rocks in this area generally outcrop in strips of varying width and composition as a result of a series of upright folds, with steep limbs. These bring to the surface rocks in age ranging from the Precambrian to the Carboniferous, the latter of which contain many more limestones.

Precambrian

Pebidian rocks are not present in this area. The Dimetian consists of the Dimetian granite and a coarse-grained dolerite of the Talbenny to Johnston Horst. These were only used very locally in rubble walls around Johnstown itself but has been extensively quarried for aggregates.

Cambrian

There are no rocks of Cambrian age in this area.

Ordovician

Ordovician sedimentary rocks (Llanvirn) outcrop in a strip from Whitland in Carmarthenshire to Narberth, with a small patch immediatly south of Llawaden. They are generally black, pyritic shales which were of no use for building. However, some thin-bedded limestones and calcareous sandstones, which ccur at the top of the sequence, were used locally for rubble walling in places such as Robaston Wathen.

The Llanvirn shales are succeeded by more limestones in the lower part of the Caradoc sequence. The Caradoc and Ashgill form a broad strip of country extending inland from near St Brides Bay, eastwards towards Carmarthenshire, and consist predominantly of mudstones and siltstones with some rare, thin, sandstone bands around Clarbeston Road.

Silurian

The Silurian (Llandovery) outcrops in two synclinal strips; a northern one stretching from Wiston Rath in the west to Llanddewi Efelfri in the east and a second one, further south, from just east of Haroldstone West in St Bride's Bay to south of Whitland. A third strip, faulted against Precambrian, occurs on the south side of the Johnston Horst.

The lowest beds of the Llandovery consist of Gething's Sandstone and Conglomerate, which were used extensively for rubble walling and dressings (eg. Llawharden Castle). It is a slightly orange, medium to coarse-grained sandstone with pebbles and is locally conglomeratic, with quartz pebbles. It is most abundant in the northern synclinal strip and has a much narrower outcrop in the southern one.

The remainder of the Silurian sequence is dominated by mudstones and silty mudstones that are of little use for building but, in the middle of the succession, is another sandstone band – the Gasworks Sandstone Formation. This occurs in two tight, upright synclines south of Haverfordwest, where the type-locality quarry is to be found. This orange-yellow sandstone was extensively used for building in Haverfordwest and surrounding communities.

The Skomer Volcanic Series (Wenlock) crops out on Skomer Island and eastwards through Marloes. It consists of lavas, basic tuffs and ashy sandstones. These have been used for rubble walling around the outcrop.

L. Silurian/Devonian (Old Red Sandstone)

The Old Red Sandstone strata forms an east-west striking strip of upland stretching from south of Whitland, in Carmarthenshire, to the Eastern Cleddau at Minwear. It includes red and maroon coloured mudstones and some sandstones and red limestones (eg. St Catherine's Church, Princes Gate). Within this sequence are a number of white quartz-dominated conglomerate bands, which were used for rubble walling.

From the coast, between Talbenny and the Marloes Peninsula, to the Cleddau at Lawrenny is a large anticlinal area, which contains a complex series of mudstones, sandstones and conglomerates. These include green-grey and maroon coloured sandstones, which were used for rubble walling. Three notable conglomerates were used for building; the Lawrenny Cliff Formation, the New Shipping Formation and the Ridgeway Conglomerate Formation. These arepredominantly maroon-coloured with mixed clasts of limestone, quartz, volcanic and other rocks. The mudstones were of little use.

Further south another narrow, tight anticlinal, east-west strip forms the ridge known as 'The Ridgeway'. Amongst other rock-types, this contains the outcrop of the Ridgeway Conglomerate, which was utilised in several churches around the ridge and, with other outcrops, over a fairly wide area. The Old Red Sandstone also outcrops on the Dale Peninsula and from Sheep Head, through Freshwater West to the cliffs north of Stackpole Quay. Here again a suite of sandstones and the Ridgway Conglomerate have been used for building in the area.

Carboniferous

The pale-to dark-grey Carboniferous Limestone forms a narrow outcrop between the Cleddau, at Minwear, and Pendine in Carmarthenshire and has been quarried along much of its length, as at

Fig. 8. (top left) Quaternary welded scree, Cwm yr eglwys, Pembrokeshire. Fig. 9. (bottom left) Caerbwdy Sandstone, Llanhywel, Pembrokeshire. Fig. 10. (top right) Coal Measures sandstone, Maenorowen, Pembrokeshire. Fig. 11. (middle right) Dundry Stone, Rudbaxton, Pembrokeshire. Fig. 12. (bottom right) Doulting Stone, Breidell, Pembrokeshire.

Fig. 13 (top). Carboniferous Limestone, Maenor Byr, Pembrokeshire. Fig. 14. (bottom) Ridgeway Conglomerate (probably), Ambleston, Pembrokeshire.

Ludchurch. The limestone, particularly the pale oolitic limestone, was used for rubble walling.

The Carboniferous Limestone also forms the southern limb of the Pembrokeshire Coalfield from the Gleddau, at Coedanas, where it was quarried on the river-bank, to Tenby. A southwestern fork of this limestone outcrop, south of the Milford Haven Old Red Sandstone, extends from Pembroke Dock to join the main outcrop west of Carew. From Pembroke Dock, eastwards to Tenby, all the villages and towns are built entirely of Carboniferous Limestone rubble walling.From Angle Bay to Lydstep and Caldy Island another strip of Carboniferous Limestone occurs in a tight syncline. This was particularly quarried at it's eastern end and was the only building stone used in Pembroke town.The southernmost area of Carboniferous Limestone forms the cliff-top plateau between Linley Head and Stackpole, including the spectacular limestone cliffs of south Pembrokeshire, and was the predominant building stone used in this area.

Namurian age (Millstone Grit) 'Basal Grit' sandstones consist of white and grey quartz-sandstones and crop out along the northern escarpment of the Pembrokeshire Coalfield. They were used in sucplaces as Haverfordwest Priory and castle, having been quarried from river bank quarries on the Cleddau.

A large escarpment of Coal Measures sandstones forms the northern edge of the Pembrokeshire Coalfield, extending from the middle of St Brides Bay eastwards to Amroth in Carmarthen Bay. These sandstones display a variety of colours and textures, from bright yellow, fine to medium-grained sandstones to coarser grey sandstones, that are characteristic of outcrops around Nolton Haven. Brown sandstones also occur and many contain small orange siderite clasts and fossil plant material.

Other stones

As in Ceredigion, imported stone forms a large proportion of the dressings used in the county. They mainly consist of: Bath Stone (85 of 158 sites surveyed), Doulting Stone (05/158), Dundry Stone (23/158) and Caerbwdi Sandstone (08/158). There are also some concrete dressings, some wooden windows and two examples of Portland Stone.

Some of the finer-grained, green-grey weathering, slightly yellowish Coal Measures sandstone could be from the Forest of Dean. There is some anecdotal evidence of the importation of Forest of Dean Pennant Sandstone into the Haverfordwest area. However, Nolton Stone is also distinctive, being a grey, coarsish sandstone which weathers to a suggary texture.Further detailed investigation is neccessary in order to refine the identification of individual yellow sandstones and match them with outcrops in the area.

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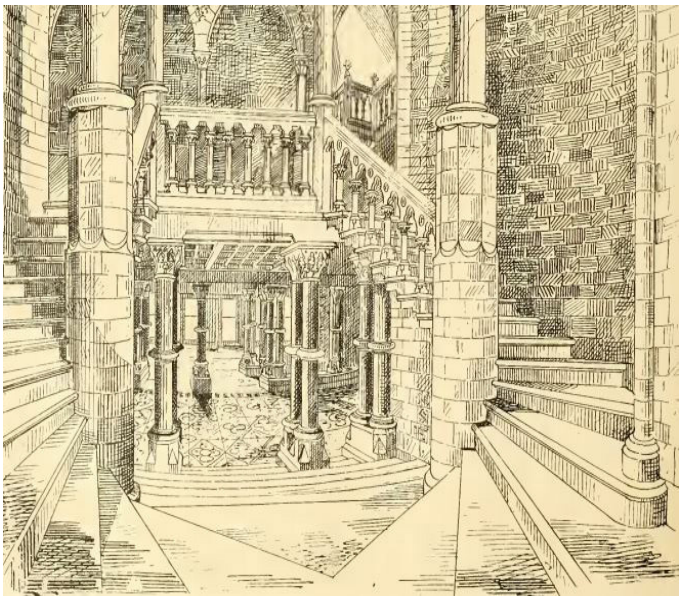
Ransome's Artificial Stone in the Old College, Aberystwyth

Tim Palmer

The famous 'Old College' on the sea-shore at Aberystwyth was built as The Castle Hotel between 1864 and 1866. The building was unfinished when the owner went bankrupt, and was bought at a knockdown price by supporters of the newly-conceived University of Wales. It eventually opened to students as the University College of Wales (now Aberystwyth University) in 1872. It is built using a variety of Welsh and English stones (Bath, Cefn, Hanam Blue, Doulting, Portland), and also of a well-regarded patent artificial stone called Ransome's Artificial Stone. This was the invention of Frederick Ransome, originally from Ipswich but later operating from a factory on the Greenwich peninsular. He developed the product over a number of patents in the 1840s and 1850s. The architect of the building, for both the failed hotel and the completed university, was John Pollard Seddon, an underappreciated gothicist and friend of the Pre-Raphaelite art circle.

The mid C19th was an innovative time for the development of artificial stones, the hope being that each would be less susceptible to weathering decay than natural stone – and cheaper too. The topic was kept in the public eye by the rapid decay in London's sulphurous atmosphere of the Magnesian Limestones that had been used only a decade or so earlier for the



Top: the new staircase, University College Aberystwyth. From Building News, April 14th 187. Bottom: The same view today.

building of the new Houses of Parliament. Some of the new artificial products were essentially concrete, some ceramic, and some siliceous. The third of these types was generally the most widely favoured and Ransome's Artificial Stone was one of them. It was made by filling a mould with a paste of loose sand and sodium silicate solution (made by boiling crushed flint in NaOH). Then the whole set-up was dunked in calcium chloride solution, whereby the soluble

sodium silicate was rapidly converted to insoluble calcium silicate. Within an hour or so a rock-hard stone could be extracted from the mould. Different colours and textures of the artificial sandstone were easily produced by varying the grain-size and colour of the parent sand. J.P.Seddon looked forward towards these improved architectural materials, as well as looking backwards to the medieval styles that were admired within the Gothic Revival movement. He used Ransome's Artificial Stone for chimneys in the first phase of building at the Castle Hotel, Aberystwyth, and was so pleased with their resistance to weathering over the fierce winter of 1864, that he wrote a testimonial on Ransome's behalf.

The chimneys were later taken down, but the main staircase, also made of Ransome's Stone, is still in use. It is very little worn, and the whole edifice is as sharp as it was when first erected – albeit rather grubbier. The material is brutally hard, and does indeed look very sandstone-like. Fireplace hoods in the same building are made of brown and pink varieties of the same material. The attached pictures show the staircase today, and a line drawing first published in Building News shortly after its completion. Seddon worked extensively in Wales in the 1850s and early 1860s and there may well be other unrecognised examples.

Stone memorials New Radnor Church

John Davies

The two effegies had lain on the north side of the porch tower of New Radnor church since the C19th and had frequently been obscured from view by such things as tables and strimmers. With the encouragement of Maddy Grey and Phillip Beddows, the church wardens decided to move them from their obscured position and place them in the south transept.

This relocation gave a splendid opportunity to examine the stone used in both, particularly the female figure because it fractured on excavation (Fig.1). The break produced a fine fresh surface and revealed the stone to be a coarse, greenish-grey coloured sandstone containing many mica flakes and large maroon mudstone flakes, up to 40mm x 20mm (Fig. 1 inset). It also exhibits cross-bedding and includes black grains up to 3mm, which may be chert or possibly Thelodont scales. This stone is certainly from the Old Red Sandstone and is very similar to 'Hay Sandstone' [Conigar Pit Sandstone Member] and almost certainly was carried to the church from the Hay area, where the rock outcrops.

Fig. 1. (above) Female effigy, Old Radnor. showing the broken surface. Inset: close up of fresh broken surface of the female effigy. Fig. 3. (below) Male figure in flaggy sandstone, Old Radnor.

The male figure is thought to be that of Einion ab Einion Clud 'Einion-y-porth' (d 1191), the Prince of southern Radnorshire, whose home was at New Radnor. This is a more flaggy, parallel-bedded to very slightly cross-bedded, micaceous sandstone and greyer coloured than that of the female figure, but may come from the finer part of the same sequence as the former (Fig.3). However, there is no sign of any maroon colouration so it may come from the Radnor Forest area.

On the same day Hay church was visited where another mediaeval effegy was examined (Fig.4). This male effegy bears a striking similarity to the female one in New Radnor and the sandstone of which it

Fig.4 Male figure, Hay

is made is also very similar and includes a small rounded quartz pebble up to 10mm x 5mm. The rock is also very micaceous and contains maroon mud flakes, some of which have weathered out. It is highly likely that the Old Radnor church female effigy and the Hay male effigy were quarried from the same sequence and possibly from the same quarry.

Oolitic Limestone

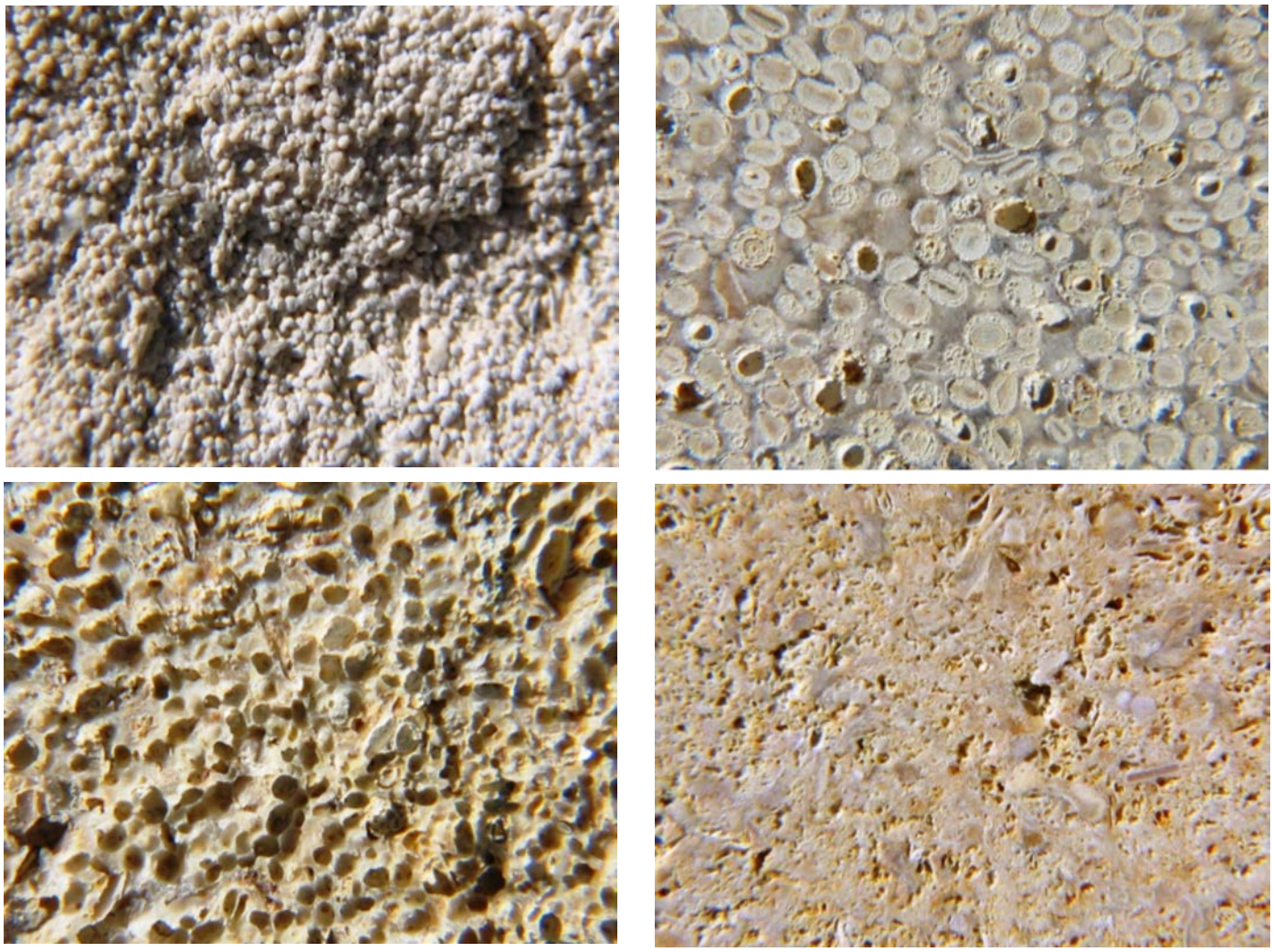
Tim Palmer

Many of the historic buildings and monuments in the more southerly counties of Britain are made of pale, easily carvable limestone of Jurassic age. The detailed geological character of these stones may point to both the provenance and the date of the monument, so an accurate petrological description is important. The first thing to determine is whether they are oolitic or non-oolitic limestones. This distinction causes much confusion, because some people think that the term oolitic limestone covers all limestones from the Jurassic limestone belt. In fact, it refers only to the specific geological character of some of them. The great majority of the limestones that we meet in monuments or buildings started as shallow seafloor sediments, consisting of clean-washed sand-sized grains of calcium carbonate. Either these grains were derived from the breakdown of shells and other calcareous skeletons, or else they grew on the seafloor by precipitation of the mineral calcite around smaller particles, just as lime-scale may grow on the inside of a kettle. This second category constitutes the ooliths. Surprisingly, they have a rather limited size range (typically from 0.2-0.8 mm in diameter (when they reached the maximum size they abraded away as fast as they grew and enlarged no further). They are also characteristically very well rounded or spherical. When sliced through and viewed microscopically, the layered structure of the precipitated calcite around the central nucleus is seen. They look like the many layers within the gobstoppers that some of us remember from our youth.

Many Jurassic limestones consist of little other than ooliths, maybe with the odd fossil or fragment. Others have much more shell debris in them, either scattered through a mass of ooliths or (more usually) in debris-rich layers that alternate with oolith-rich layers. This pattern reflects the surging of currents during the initial accumulation of the sediment and is very evident in limestones from near Bath. Other limestones accumulated on the seafloor in areas where ooliths did not form, so the resulting limestones only contain shell fragments from the invertebrate fauna that originally lived there. Geologists refer to these as bioclastic limestones.

Because the smooth spherical character, size-range, and abundance of ooliths is highly distinctive, there should be no problem in recognising them on a cut or rubbed stone surface, especially with a magnifier (no-one should ever venture out without one!). Even the concentric laminations and the nucleus may be clear on close inspection. Experience will soon allow distinction between an oolitic limestone and a limestone that is principally composed of comminuted shell debris.

However, there is a further complication that may cause one oolitic limestone to look rather different from another. This is the disposition of the natural mineral cement within the stone. Limestones acquire their hardness by growth, during burial, of calcite crystals in the minute holes (pore space) between the grains. This material is popularly called ‘spar’. Some oolitic limestones (e.g. Ketton and Portland) are held together by tiny dabs of spar, principally at the points where adjacent ooliths touch. This is quite enough to give the stone rigidity, and a close look will show the ooliths themselves looking like ball-bearings in a box with the spar not evident [Fig 1]. But other oolitic limestones (e.g. Bath, Fig.2) have their original porespace completely filled with spar, so that the ooliths at the cut surface of the stone may fall away to reveal a surface texture dominated by the



Close-ups of 4 different types of Jurassic limestone, all important stones for buildings and monuments. Each frame is c. 2 cm wide and shows what you would expect to see with a x10 magnifier and a clean surface. Fig. 1 (top left) Portland Stone with grain-prominent, small ooliths. Fig. 2 (bottom left) Bath Stone with spar-prominent texture. Fig. 3 (top right) Painswick Stone with most ooliths held tightly by the natural cement. Fig. 4 (bottom right) Dundry Stone with no ooliths, only shell fragments.

concave moulds in the enclosing spar – like close-packed egg-cups on a tray. The first type is referred to as a grain-prominent oolitic limestone, and the second as a spar-prominent one. Yet others have lots of spar, but the individual ooliths are stronger and tend to remain in their little sparry cups at the cut surface. Painswick Stone [Fig.3] from north of Stroud frequently shows this character.

Why, then, are some of the most distinctive non-oolitic limestones that contain only shell debris (Doulting Stone and the highly-important medieval Dundry Stone [Fig.4]) come to mind) persistently and erroneously referred to as oolitic when they are nothing of the sort? Geologists are not completely blameless, because the major Jurassic limestone sequences that run south-west to north-east across England were, in the C19th, referred to as the Lower, Middle, and Upper Oolites. The Lower was the most widespread and economically important, comprising the Great Oolite of the Bath region, and the Inferior (= subjacent) Oolite near Cheltenham. These stratigraphic units contain many different varieties of limestone of which only some are oolitic, but the name (maybe because it is such a euphonious word) was applied to the whole sequence. Then the historians of architectural materials came along and found it convenient to refer to this swathe of country as the Oolite Belt, and the trap was sprung. Ergo an oolitic limestone is any limestone from the Oolite Belt. Except, of course, that it isn't.

Dundry and William 'Strata' Smith

Martin McNamara

Dundry Hill near Bristol is well known to Forum members as an important source of freestone that can be found in Wales. Thanks to Tim Palmer we know Dundry Stone to be a Jurassic limestone and how to recognise it. This easily worked yet hard-wearing stone was widely quarried, worked and used in

and around Bristol but also shipped out through the Severn but the quarries and mines have been closed for some time. In 2006 we visited Dundry Hill with Tim Palmer and John Davies who drew our attention to the hill, the stone and its history.

Since then, inquisitive Forum members seek to know how, in pre-Reformation times, large quantities of stone were taken from the hill to the Welsh Backs Quay in Bristol docks where it was shipped to south and west Wales for use in Welsh churches, abbeys, castles and cathedrals. We enjoy finding it, sometimes unrecognised and unrecorded, as baptismal fonts, effigies, carvings and dressings. In dark church corners, lit up by a torch, we peer through a jewellers loupe looking for Dundry Stone's distinctive matrix. For me, and I think others, because of its history it has become a fascinating, romantic stone.

Earlier this year I read, *'The Map that Changed the World: The Tale of William Smith and the Birth of a Science* ', by Simon Winchester. I am sure that members will know this book and are well aware that its subject, William Smith, produced what is regarded as the first true geological map of a country in 1815 and that he is known as the 'Father of English Geology'. However, I would like to draw members' attention to the connection of Dundry Hill to William Smith and the part it played in the birth of the this new science of geology.

From his work as an engineer Smith came to realise that the strata of southern England always occurred in the same regular order and that each stratum contained particular fossils, which meant that he could identify where any layer of rock came from within the overall sequence of strata, countrywide. On the evening of 11th June,1799, Smith explained his ideas to two friends, the Reverend Joseph Townsend and the Reverend Benjamin Richardson, at 29 Great Pulteney Street, Bath, and organised Richardson's large collection of fossils and rocks in to what was to him a logical order; the oldest at the bottom and younger at the top claiming that '*the same strata are always found in the same order of superposition and they always contain the same peculiar fossils'*

Richardson and Townsend encouraged Smith to publish his discoveries and that same night he dictated the ***Order of the STRATA and their embedded ORGANIC REMAINS, in the vicinity of BATH; examined and proved prior to 1799.*** 'Each person took one copy' wrote a Bath city historian of the time, 'and was encouraged to make further copies as necessary.' A science was started–an elemental, basic science.

Winchester wrote that "Rev. Townsend and Richardson suggested putting Smith's theory to the test. If Smith was right, then he should be able to predict with some accuracy what rocks would appear, and what fossils would be found, on both the slopes and the summit of a hill nearby. They chose the hill near Bristol where Dundry Church had been built." Smith rose to the task and predicted that Dundry Hill would be capped by Inferior Oolite limestone and that on the western side it would be possible to find a series of Lower Jurassic fossils, which was proven correct when they visited the site.

Soon after Smith sketched a circular map showing the rocks of the Bath area and then went on to produce his geological map of Britain entitled ***A Delineation of the Strata of England and Wales with a part of Scotland*** which was published in late 1815. The hand-coloured map measured 6 feet by 8 feet 6 inches and was on a scale of 5 miles per inch. Many of the colours that he chose to represent the different strata can still be seen on modern British Geological Survey maps.

The map was not a financial success and Smith's lack of formal education, money and connections seems to have been held against him. His map was plagiarised by members of the Geological Society, from which he was snubbed by the patrician membership. He was financially ruined and spent time in The Kings Bench debtor's prison in Southwark and upon release went to live and work in Yorkshire.

It was only much later in his life, after lobbying by his supporters and friends, that Smith received the recognition that he deserved for his work. In 1831, at the age of 62, he was awarded the Geological Society's first Wollaston medal and in 1832 the Crown awarded him a pension of £100 pa. He died in 1839. The Geological Society realised eventually that an injustice had been done and, in 1865, gave him due credit for his work.

Dundry Hill is the place where William 'Strata' Smith's theory was first tested by his peers and proved valid. It gave confidence to Smith and his supporters, gave impetus to the making of his map and contributed to the birth of the new science of geology. Perhaps we could think of Dundry as 'The Hill That Changed the World.'

FIELD MEETING REPORTS

AGM & & Quarry Visit, Pontypridd. 9th April 2016

John Shipton

Following the Forum's AGM, held at Pontypridd Library, Graham Lott (formally a building stone specialist at the British Geological Survey) gave a lecture on the Pennant Sandstone Formation, of Carboniferous age, in South Wales. These rocks form the upper part of the Coal Measures seqence in South Wales and, being relatively resistant to erosion, have been used widely for construction in and around the South Wales Coalfield and beyond from medieval times until the 2nd World War.

Graham described the coalfield valleys as being 'wild and wooded' in the C18th. However, during the late C18th many of the oak trees that clad the valley sides were felled for the Navy. The valleys suffered further changes following the rapid expansion of the coal mining industry in the C19th. Many large structures were built to facilitate the extraction of the coal and much of this was undertaken using Pennant Sandstone with Radyr Stone (that was available not to far away) for decoration in some places. Local transportation of the stone and coal was on tramways with longer distances being achieved by canal and then the railways.

A considerable amount of labour was required for the coal and associated industries and, during the C19th, the population of the coalfield area grew ten-fold, from 81,000 to 890,000. Many of the houses constructed to house this population were also built of Pennant Sandstone. The demand for this stone promoted a huge growth in quarrying and, during the period from 1884 to 1939, it is recorded that there were over two thousand quarries in the area producing building stone. Now there are only two quarries remaining and all of their production goes into the crushers for use as road stone.

After lunch we travelled a few miles north on the B4273 to Craig yr Hesg Quarry, where Hanson's quarry Blue Pennant Sandstone. We were met by Julian, the Site Manager, who informed us that the stone from this quarry had a very high skid resistance, making it ideal for use in road surfacing. It is widely used throughout south Wales and southern England and has been used on a number of major projects, including the runway at Heathrow Airport and surfacing the M25 motorway.

Fig.1 Processing plant, Craig y Hesg Quarry

Quarrying began at Craig y Hesg around 1885 and at one stage more than 100 people worked at the site but today the quarry only employs 16 staff. We were told that reserves of stone are now running low and a planning application had been made to extend the existing quarry. If permitted the extension would release a further ten million tons of rock, none of which would be available for building as it would all go to produce road stone and concrete aggregate.

Following a safety briefing in the quarry office, and suitably equipped with high visibility vests and safety helmets, Julian led us out into the quarry. We passed an impressive display of dump trucks and front-end loaders, on past the sheds, crushers and conveyors for processing the stone (Fig 1.), to where an access road, wide enough to cope with the large mechanised transport, wound its way up around the quarry. This led to a vantage point above the great hole in the ground that was the working quarry. On the way up we passed many vertical faces where the Pennant Sandstone had been worked (Fig.2). It was clear that much of the stone that had been removed would probably have been suitable for building. Many of these faces were now quite old and nature was beginning to take back control. In fact a pairof

Fig.2 Pennant Sandstone in old quarry face

Fig.3 View of Craig y Hesg quarry from the viewpoint

Peregrine Falcons now nested on the site but the exact location was kept secret. From the view point we could look down into the quarry (Fig.3) and imagine the volume of stone that had been won from this quarry alone. Julian informed us that the bottom of the quarry was the extent of the usable rock and that they had started backfilling the hole with waste material arising from the quarrying process. Eventually the whole site was to be backfilled. After looking at the proposed extension area we made our way back down the track to the quarry offices. On the way we passed many large pieces of Blue Pennant Sandstone lying on the side of the track that appeared to be eminently suitable for building work.

We had been very fortunate with the weather during our visit and before we all went our separate ways John Davies thanked Hanson's for their hospitality and Julian for giving up his time to provide us with an enjoyable and informative tour of the site.

Penarth: 21st May 2016

John Shipton

The aim of this joint meeting with the meeting South Wales Geological Association was to examine the natural outcrop of Penarth alabaster and its architectural and artistic use within the Cardiff area.

We met our leader, Michael Statham, on a grey overcast morning in the Cardiff Bay Barrage car park before moving off, along the rocky shoreline beneath Penarth Head, to where gypsum (alabaster) outcrops in the cliffs above the shoreline. The alabaster was formed during the upper Triassic Period, about 210 million years ago, when the area was a hot desert that lay at a latitude similar to that of the present day Sahara. Gypsum (calcium sulphate dihydrate) was precipitated from salt-saturated desert lake or lagoon water. These horizons, in places, are up to about 0.32m thick. As these layers were buried under successive layers of sediment, increased heat and pressure altered them to calcium sulphate (anhydrite).

Fig.1 Gypsum outcropping at Penarth Head.

Later erosion of the overlying rocks exhumed the beds, eventually leading to their rehydration into gypsum.

Several layers outcrop in the cliffs between Penarth Head and Lavernock Point. At Penarth Head two thick layers occur just above beach level (Fig.1). The upper layer is far more colourful than the lower, being generally pink in colour (caused by the presence of iron) but containing red, green, grey and black inclusions. The lower has much less pigmentation and towards Lavernock Point is observed in a pure white form. As the soft mudstones that lie above and below the alabaster erode, boulders of alabaster fall out of the cliff and litter the shore. It was obviously unsafe to inspect the alabaster at the base of the unstable cliffs, but there were plenty of examples for members to inspect on the foreshore further away from the cliff face. Michael eventually managed to persuade the group to move on to the next stop at St Margaret's Church in Roath, Cardiff.

Although built on the site of a medieval chapel the current St Margaret's church was constructed in the second half of C19th and was completed in 1870. From outside the church looks quite plain, being built of Pennant Sandstone, but inside, beyond the porch, is full of vibrant colours. John Benjamin described it as 'a glorious polychromatic interior', the large crossing alone containing four different stone types, including Penarth Alabaster. Much of the alabaster used in

Fig. 2. Andrew Haycock inspecting alabaster in the columns of St Margaret's, Roath.

structural situations i.e. columns, was thought to be cladding as alabaster does not possess the strength to be used in structural work (Fig. 2). Being slightly soluble in water it is only suitable for internal use, as shown to the left hand side of the magnificent carved and gilded reredos, where water penetration from outside was causing degradation of both the Old Red Sandstone and alabaster stonework. After visiting the Bute Mausoleum, where nine members of the Bute family lie, including the first Marquis and his two wives, members inspected a font that is decorated with black marble inlaid in the form of a Maltese cross, at the centre of which is an inlaid square of Penarth alabaster (Fig. 3).

The party then moved on to St Michaels church, Michaelston-y-Fedw, to the east of Cardiff. This church, which is of indeterminate age, has been much altered over the years since medieval times and contains building styles from a number of different periods as well as two wall memorials which contain Penarth alabaster. One, which is C16th, was probably originally made of alabaster from Watchet in Somerset and later repaired with Penarth alabaster. The other is a WW1 memorial tablet framed in Penarth alabaster.

Fig. 3 (top) Font with inlaid back marble cross and Penarth alabaster, St Margaret's, Roath. Fig 4. (middle) The staircase, Insole Court, Llandaff. Fig 5. (bottom) Penarth alabaster in the reredos, St Catherine's, Canton.

Alabaster from the English Midlands, which is more translucent than the Penarth variety, occurs in other memorials in the church.

After lunch at the Cafn Mabley Inn some of the group set off for Insole Court in Llandaff, Cardiff. This

house was originally built in 1855 but in the 1870's was altered to reflect the architecture of the Gothic Revival. Here, members inspected the Penarth alabaster incorporated in the entrance hall, including the main staircase (Fig.4), first floor landing and library.

From Insole Court a small group went on to visit St Catherine's church, in Kings Road, Cardiff, where the reredos (dated 1916) contains elements of Penarth alabaster (Fig.5). After inspecting this, and the rest of the church, Mike was warmly thanked for leading the trip before we braved the by now heavy rain and departed for our homes.

Michael Statham's study is now avaiable as a WSF forum publictaion, produced with support from the Curry Fund of the Geologist Association. See bck cover for details.

Haverfordwest 2 (revisited), 18th June 2016

John Shipton

On the morning of the meeting a small group of members assembled in a car park on the eastern bank of the River Cleddau, just 500 metres downstream and south of Haverfordwest town centre. Being a fine dry day Jana Horak spread the geological map of the area out on the ground and pointed out that Pembrokeshire exhibited, in effect, a condensed version of the geology of south Wales. She explained that Haverfordwest sits predominantly on rocks of Silurian age with Carboniferous rocks outcropping further south and Devonian rocks further south again. Before moving off Robin Sheldrake, the excursion leader, indicated the location of the limestone quarries at Darby Farm, downstream from Haverfordwest.

Walking north about 100 metres along the road towards the town we reached the SSSI at which Gasworks Sandstone Formation outcrops. It was very overgrown but John fought his way to the old quarry face where he was able to show that the rock was a very muddy, foliated sandstone and quite richly fossiliferous.

Twenty metres further on, the railway line emerges from a cutting to the east, and crosses the Gasworks Lane on a bridge, the abutments of which were built using a stone that was thought to be sandstone of the Slade and Redhill Formation of Ashgill (Ordovician) age, that outcrops locally. Robin explained that the railway arrived in 1853 and that the railway bridge over the River Cleddau has a lifting mechanism which permitted the passage of sailing ships up to the port of Haverfordwest. Clearly the arrival of the railway did signal the end of the river traffic and the end of the port. Stood on the bank of the river opposite the Priory ruins, Robin pointed out a number of quay's and buildings that once served as warehouses or housed service industries for shipping i.e. rope makers and blacksmithing.

Moving on we crossed the river on a modern footbridge with a view upstream of the 'New Bridge' (Fig.1). The town's 'New Bridge was built circa 1829 of finely cut blocks of Carboniferous Limestone laid with very fine joints. At the old quay side are sandstone blocks exhibiting ripples on their underside, showing that the blocks have been lain upside down. The specific origin of the stone was not identified but appeared to be either Silurian or Ordovician. Nearby, the wall of the Old Wool Market was seen to be built predominantly in random rubble Carboniferous Limestone, while another contained pieces of a Jurassic limestone, which was considered to be Painswick Stone. In a park above Quay Street, quoin stones in a wall are cut from an unidentified conglomerate (Fig.2). Jana suggested that this was probably built in the 1920's and therefore there should be records of where the stone was quarried. It's identification would be added to the "to do list".

On the corner, at the bottom of Hermons Hill where it meets Goat Street, a flight of steps led down towards Hill Lane. Here, an adjacent parapet wall is built in local sandstone topped with pieces of black shale laid on end, soldier fashion, which in turn had been capped more recently with a sandstone that appeared to be Forest of Dean Pennant Sandstone.

Having decided to lunch at Georges we made our way westwards along Goat Street passing a wall adjacent to Foley House. The piers of this recently built wall were in ashlar blocks of Forest of Dean Pennant Sandstone. On the junction of Goat Street and Market Street stood the Old Corn Market (Fig.3). The bottom three or four courses of the external walls are built of Carboniferous Limestone ashlar blocks with 'sparrow pecked' faces and dressed margins. The corner detail of the building was built on a small radius, approx 450mm, and above the ashlars this quadrant detail is set between rendered walls. This had been constructed using an unidentified sandstone, with a course of Carboniferous Limestone every two or three courses, run off from which was accelerating the erosion of the sandstone. The spacing of the limestone courses is not symmetrical and the blocks are quite irregular in size and shape so it is unlikely that it had been built that way for aesthetic reasons. It was my view that this detail would have originally been rendered, but not all of those present agreed.

After lunch we made our way down Market Street to St Mary's Church. The main body of the church

Fig. 1. (top left) The 'New Bridge' built of finely cut blocks of Carboniferous Limeston. Fig. 2. (middle left) A quoin of unknown conglomerate. Fig 3. (bottom left) The Old Corn Market. Fig. 4. (top right) Andrew Haycock inspects a compound column, St Mary's Church. Fig. 5. (bottom right)Chert nodule in Carboniferous Limestone, Haverfordwest castle.

was built in the C12th but was probably rebuilt in the mid C13th after being damaged by Llywelyn the Great. The fabric is predominantly of Coal Measures sandstone and Carboniferous Limestone, with early dressings in Dundry Stone. Dundry Stone is a Jurassic limestone from south of Bristol and is also present in quoins on the northeast corner of the church and a buttress on the northeast elevation. Inside, the interior is impressive. Jana noted that the arcade has been described as being constructed from Caen Stone (ref.), and although heaviliy coated with lime wash, close examination suggested that this was Dundry Stone, with one compound column having inset columns of Carboniferous Limestone (Fig.4) this being described in @@@@ as being a painted surface. Leaving the church, and making our way towards the castle, we passed the Bethesda Baptist Church school room. Here, John Davies spotted a small window with Bath Stone dressings and above which a relieving arch had vousoirs cut from conglomerate, which John identified as being from the Middle Devonian, Old Red Sandstone. The surrounding wall is of blocks of Carboniferous Limestone.

Haverfordwest Castle was first established around 1120 but much of what remains today is dated from 1290. By the C16th the castle had become dilapidated

but was refortified during the English Civil War, before Oliver Cromwell ordered it to be demolished in 1648. In 1779 the remains were converted to a prison and in 1820 a new prison building was constructed. This was used until the inmates were transferred to Carmarthen gaol in 1878. The building has had a number of subsequent uses, but today it was open to the public, so we went inside.

On the grass outside of the 1820 prison building, lay a large rock with an inlaid memorial plaque, which upon inspection proved to be a dolerite glacial erratic. We transferred our attention to the 1820's prison. This is built of local sandstone with quoins of Carboniferous Limestone, the cut blocks of which contain many chert nodules (Fig.5). We moved into the grounds of the medieval castle which are now laid to lawns and paths. The castle sits on an outcrop of Late Ordovician strata; the Portfield Formation, comprising grey carbonaceous mudstones and the Cethings Sandstone Formation comprising fine-grained, well sorted sandstones, which in this location are almost perpendicular and oriented east to west, directly under the castle. What remains of the medieval structure had been constructed in sandstone similar to the Cethings Sandstone Formation along with blocks of Carboniferous Limestone. Many of the dressing have been removed but those that remain are of grey sandstone, most likely of Nolton Stone (Carboniferous, Pennant Sandstone Formation) derived from the coastal village of Nolton, some seven kilometres to the west. At higher levels, that were inaccessible to us, are dressings in a pale cream limestone, probably Jurassic and possibly Dundry Stone, but this remains unconfirmed. From there we walked from the castle to the town centre where we all thanked Robin for organising the day.

Neath Abbey & Neath Town: 9th July 2016

John Shipton

July's excursion, led by Tim Palmer, was to Neath town and Abbey. The abbey, a large and well-preserved medieval Cistercian site is built with a variety of Welsh and English stones. Tim gave a brief history of the site, which was originally founded as a daughter house of Savigny in 1130 before being absorbed into the Cistercian order in 1147. Fairly complete surviving parts include the C16th mansion raised within its precincts following the dissolution of the monasteries. By 1730, some of the buildings were being used for copper smelting and the rest were abandoned. The site is now in the care of Cadw.

Within the cloisters, members inspected the outside wall of the Lay Brothers Refectory which is constructed predominantly of rubble Pennant Sandstone, an Upper Carboniferous age sandstone from the South Wales Coalfield. When fresh it is a bluish-grey colour but turns brown with age due to the oxidation of iron within the sandstone. It is a medium to coarse-grained stone composed of quartz sand grains, some feldspar (which has rotted away to leave voids that can be seen under a microscope) as well as some fragments of pre existing stone and weathers quite well.

Tim explained that where Pennant Sandstone was used in south Wales invariably a different stone, possibly imported, was used for dressings. In medieval times Neath Abbey used Sutton Stone (Fig. 1), a marginal facies of the Jurassic Blue Lias. This is in effect a conglomeratic limestone which contains pebbles of older Carboniferous Limestone, as well as bioclastic limestone and broken shell material. In places it also contains some minerals including barytes (barium sulphate) and galena (lead sulphide) flushed up from the Carboniferous layers below. Inside the refectory Sutton Stone has been used for the majority of dressings, but Tim did point out an isolated block of Dundry Stone from near Bristol and a piece of bioclastic limestone containing broken crinoids and molluscs.

On the day of our visit Cadw were holding an open day and masons were demonstrating their stone cutting skills (Fig.2). Tim identified some of the stones; one block was Stoke Ground Bath Stone and another Doulting Stone. The latter contains no ooliths but is composed of broken pieces of crinoids to form a gritty sandstone. The mason informed us that the stone came from the stone pile in Caerphilly Castle yard and had been salvaged from the church that once stood at Gabalfa, in Cardiff, that was demolished during the construction of the Gabalfa fly-over in the 1970s. If memory serves me correctly it was a similar stone, from the same stock pile, that members saw a Cadw mason cutting when we visited Caerphilly Castle for our AGM in 2010. The mason told us it was a very good stone to carve; they must be keeping it for demonstration work.

Moving into the abbey proper, Tim pointed out a number of lumps of barytes (barium sulphate) in ornate Sutton Stone dressings. We moved over to a stone store to see if there were any other pieces of interest, but it was mostly more of the same; Pennant Sandstone and Sutton Stone. We did spot some sandstone that could have been Quarella Sandstone from the Vale of Glamorgan, but we could not be sure that it came from the abbey as Neath Abbey had in the past been a base for Cadw masons and it could have been brought there from any other outlying monuments.

Fig. 1. Sutton Stone quoins and Pennant Sandstone walling, Neath Abbey. Fig. 2. Stone mason demonstration, Neath Abbey. Fig. 3. No 8, Wind Street, Neath. Fig. 4. The entrance to the General Market, Neath.

The afternoon found us gathered in front of the C14th gate house, which is the main surviving feature of Neath Castle. The main fabric is of rubble Pennant Sandstone, with the remaining dressings over the main gate and blocked up windows cut from Sutton Stone.

Pevsner describes Neath as the best of South Glamorgan town centres so it was with an air of expectation that we left the castle and moved into the town. We first stopped at the Mechanics Institute building, a purely functional building built in 1847 with course blocks of Pennant Sandstone and cement render detailing around the windows and doors. No 8, Wind Street, has the front elevation built in a number of styles and materials (Fig.3). The first 3m are of Pennant Sandstone ashlars with sparrow-pecked faces and draughted margins. Above this, to the underside of the first floor windows, are courses of Pennant Sandstone blocks with a rough face. The remaining elevation to the first and second floors is built in Pennant Sandstone blocks of assorted sizes, creating an irregular coursed appearance. Some red bricks have been employed at higher levels, while a string course, dental course, window heads and cills are in Bath Stone. Members discussed the provenance of the Pennant Sandstone in this building and it was decided that, due to its colour, it could have been Forest of Dean Pennant.

A little further along the street a shop selling food supplements had Scandinavian Larvikite cladding above and below the display windows. This igneous rock, notable for thumbnail-sized crystals of sparkling labradorite feldspar, was used on nearly all of Burtons Menswear shops and, sure enough, an inscription at ground level informed that "This stone Laid by Arnold James Burton 1937". Neath General Market was originally built in 1837 before being renovated in 1904 when a new stone portico was added (Fig.4). Most of the front is Pennant Sandstone which, due to the thickness of the beds, may well have been Forest of Dean Pennant. In the centre of the portico is a stone relief depicting Neath's industrial heritage. It has been cut from an unidentified red sandstone that Tim thought could have been St Bees, a Triassic age red sandstone from Cumbria . However, close inspection was impossible as it was approx 15m above street level.

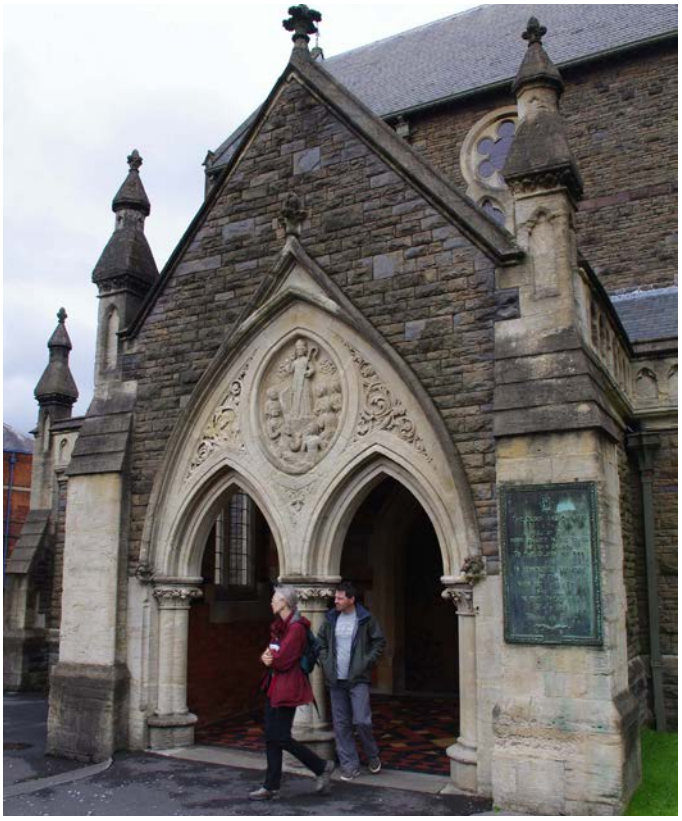


Fig. 5. St Mary's Church, Neath.

The commercial banks in Neath wore similar 'uniforms' to those that they sport in other towns. Natwest Bank, built in 1925, is dressed in Portland Stone, the ooliths of which had fallen out and it was quite shelly. HSBC Bank on Winsor Road is clad in Bath Stone and some repairs/indents had taken place where damage or degradation had occurred. At No 5 Windsor Road, Lloyds Bank has impressive Portland Stone columns around the entrance.

Our final visit of the day was to St David's Church, a large building in the gothic style built in the 1860's in Pennant Sandstone with Bath Stone dressings (Fig.5). This church was normally open to the public but on this occasion was locked so we had to content ourselves with a look around the outside. Making our way around the building it was noted that worm burrows were evident in some of the Box Ground Bath Stone dressings. The Gothic arch above the sheltered west door is constructed in three layers; a relieving arch in the Pennant Sandstone over two layers of dressed stone. Nothing unusual in that you might say but here, although the predominant stone in the dressings is creamy Bath Stone, alternate voussoirs are cut from red sandstone that are staggered in the top layer to give a colourful chequered effect. It was thought that these red sandstones probably come from Staffordshire or the English Lake District. At 15.30 Tim closed the meeting and Judith proposed a vote of thanks to Tim for arranging the excursion.

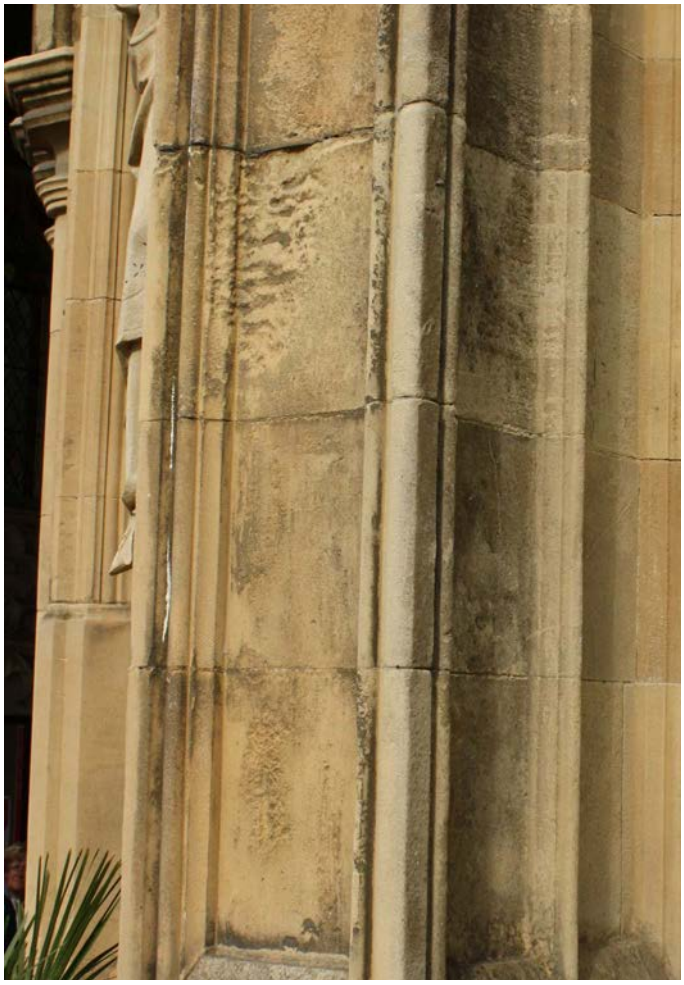
Gloucester Cathedral: 8th October 2016

John Shipton

Although the Forum has strayed onto the eastern side of Offa's Dyke during past field excursions this excursion was, as far as I am aware, the first time that the Group has undertaken a sole visit to a building outside of Wales. The reason for this trip was explained by Tim Palmer in an email to members, prior to the trip in which he pointed out that it would be an excellent chance to see some of the western England stones that are encountered more rarely in Wales; Painswick, Bath, Pea Grit, Brockhampton as well as Lias, all of which are clean and well exposed on the southern side of the building's exterior. Dundry stone, so abundant in Bristol and along the southern Welsh coast, is not seen here and recently French stone, that is a good match for the oolitic Painswick Stone, has been used for repairs. During the trip we would look at aspects of the masonry as well as the materials themselves. After lunch, Dennis Jackson would show us some to the range of ornamental stones used in the monuments inside of the cathedral. A sizable group assembled outside of the cathedral in preparation for the day's activities. Tim had intended to start our inspection on the exterior of the building but, due to an unexpected closure of the crypt in the afternoon, it was decided to make a visit to the crypt our first port of call, led by Dr Dennis Jackson. Much of the fabric of the crypt is of Painswick Stone, but the main reason for visiting the crypt was to view the large font made from red-coloured granite, that had been moved from the nave to the crypt for aesthetic reasons (Fig.1). This font was originally described as being of Inverness Granite but this has been shown to be incorrect and it is probably Swedish Red, brought by ship to Aberdeen, carved in 1876 and then brought to Gloucester via London.

Returning to the exterior of the building we began getting to grips with the different yellow-coloured limestones used in this impressive building, with the aid of Tim's excellent hand out. Built in Norman Romanesque and Gothic Perpendicular style most of the fabric of the cathedral is of Painswick Stone, a pale, yellow oolitic limestone full of spherical ooliths, which tend to be held in by the cement matrix at cut or broken surfaces . 'Painswick' is a generic name for the limestones from the Lower Inferior Oolite that were quarried along the Cotswold edge, between Birdlip and Nailsworth, until the last quarry closed in 1963. This is the main building stone used from medieval times up until the C19th (Fig.2). There are also reused Roman examples. The stone used during the Victorian period is typically more heavily bedded than the older material. There is very little Painswick Stone found in Wales, but there some occurs in the remains of Strata Florida Abbey, although the dressings there are mostly of Dundry Stone.

At the base of the walls and buttresses, where ground water causes more severe weathering, more resistant stone has been used. Much of this is Pea Grit, from



Birdlip, an Inferior Oolite, pisolitic limestone full of shells, that is well seen on the south elevation. It is widely thought to be reused Roman material and was used into the C12th. In later phases of building Pea Grit was replaced by Minchinhampton Weathering Stone (Fig.3), a pale, shelly, oolitic limestone from the lower part of the Great Oolite (same age as Bath Stone). In this stone the ooliths readily fall away from the matrix to leave little hemispherical holes in the calcite cement. The stone is well seen in the base course of the Lady Chapel and the south aisle buttresses. The Minchinhampton Weathering Stone used by the Victorians tends to be less shelly and

looks more like typical Great Oolite, such as Bath Stone. Michael Statham pointed out that like Bath Stone, Michinhampton Stone was mined rather than quarried.

Further along the building we saw a reused, fire damaged stone with pink ooliths and, in the same area, blocks of Painswick Stone which were riddled with crustation burrows. Modern repairs to the buttresses have been predominantly carried out using imported French stones (Fig.2). Since the late 1960s, these have been, Lavroux (also called Lepine) and Beaunotte – Beauval. Lavroux is used as a substitute for the Painswick Stone and is rather like Caen Stone in appearance. It contains a lot of small fragments of echinoderms, which support a strong calcite cement within the stone. Beaunotte – Beauval is also rich in echinoderm fragments but is coarser grained and is used where a better weathering stone is needed, such as in gargoyles. Recent replacement blocks had been inscribed by masons marks and I found and photographed six different marks.

Moving back past the south door Tim pointed out dressings in Bath Stone that were degrading badly. Mid C19th repairs were widely carried out in Bath Stone, which is best seen on the outside of the west end of the cathedral. This stone tends to weather to a dull orange colour in protected areas but decays badly where most exposed. Because of this the decision was taken to stop using it in 1873. Sometimes it develops a yellow skin as gypsym or calcite containing iron is carried to the surface by moisture. A better Bath Stone is Box Ground Stone from the Combe Down Oolite, a very shelly and harder wearing stone.
In the mid C19th small quantities of other stones were experimented with. The most conspicuous of these is Anston Stone of which the first 8 feet of the south porch is built (Fig.4). This is a dolomitised limestone from the Permian of south Yorkshire. It has a fine sugary sparkle in sunlight, due to the light reflecting off the faces of the small dolomite crystals.

Above the base course of the Lady Chapel, at the east end of the cathedral, are three courses of Brockhampton Stone, a yellow, oolitic limestone from the Inferior Oolite of the northern Cotswolds, where the abbey had an estate. It was used in late medieval times and looks more like Bath Stone except for the yellower colour. This stone is now available as Guiting Stone. Although not used as a building stone in the main fabric of the cathedral, grey-blue coloured, muddy, Liassic limestones of the latest Triassic and early Jurassic age have been used for walling in some of the accessory buildings.

The afternoon was spent in the company of Dr Dennis Jackson who guided us around the tombs and monuments within the cathedral and provided us with information regarding their ornate stones. Unfortunately, our tour coincided with an organ recital and as time went on the volume of the music increased making it difficult to hear all the information being provided. I hope that the reader will understand that any inaccuracies in the following account are down to the recorder being unable to hear and not that he was daydreaming!

Just inside the door stands a statue commemorating Edward Jenner carved in white Statuario Carrara marble. Moving along the south aisle we came to a large, wall-mounted, Baroque monument containing Belgian Black marble but also spiral columns in polished Carboniferous Limestone. Another rather grand, free-standing monument to the English prison reformer George Onesiphorus Paul, is also of Statuario Carrara marble. Nearby is a colourful wall-mounted memorial to Mary Singleton (died 1761), which contains yellow Giallo de Siena marble, white Sicillian marble and is topped with grey Bardiglio Fliorito marble (Fig 5). In the same area there are memorial plaques containing green coloured Connemara Marble and a blue inlay thought to be Lapis Lazuli or serpentine. In the Seabrook Chantry chapel is a tomb chest and alabaster effigy of Abbot Seabrook (1457) who was responsible for the construction of the current cathedral tower.
In the south transept is the Black Belgium marble tomb chest with recumbent effigies of Alderman Abraham Blackleech and Gertrude. Nearby a tomb slab, set in the floor, caught the eye of a number of members who identified the stone as being Purbeck Marble. Set within a decorative tiled floor in the choir, John Davies spotted a polished red stone that was thought may have come from the French Alps. In the north ambulatory the large memorial to Judge John Powell is in white Sicilian Marble and Belgium Black, while the effigy is alabaster. here also a simple plaque commemorating Arthur Caylem is framed with Purbeck marble.

Dennis led us to the tomb of Edward II, which is topped with a canopy that was reportedly cut from Painswick Stone. Strangely, no ooliths were visible in the stone, which puts a question mark over this identification. However, as the canopy has been

repaired many times over the years with plaster maybe it was plaster that we could see rather than the actual stone? The base is of Purbeck Marble that has a strange redness, which Tim thought might have been caused by the stone being treated or coated with oil. The effigy is of alabaster, probably from the English midlands.

Moving into the north aisle we passed a modern memorial plaque to Edward Charles Summer Gibson made of Hopton Wood Stone, a Carboniferous limestone from Derbyshire. A colourful late C19th memorial to Canon Edward Douglas Tinling (Fig 6) contains alabaster, Verde Antico marble, Pier de Pesco marble and Lapis Lazuli with a bronze figure kneeling before Christ set on a corbel within the memorial. Penultimately, we viewed a Flaxman memorial to Sarah Morley, who died at sea in 1784 returning from India This has a seascape cut in alabaster at its base and various marbles on the sides and back panel. The final memorial to be viewed, close to the cloister door, was to Charles Rudhall. This has a surround of a black, Lower Carboniferous limestone full of the brachiopod Davidsonia, which Andrew Haycock identified as being Snowdrop Marble probably from the Pendine area of Carmarthenshire (see Andrews's article in this Newsletter).

We had seen a lot that day and as many of us had a long drive ahead of us so John thanked Dennis for acting as our guide and closed the meeting at 15.35. Those who didn't have to leave immediately had time to view the magnificent fan-vaulted cloisters and seek refreshment in the cafe.

Fig.1 Red granite font in the crypt
Fig.2 Painswick Stone with replacement blocks of French Stone
Fig.3 Minchinhampton Weathering Stone
Fig. 4 Anston Stone in the porch.
Fig.5 Memorial to Mary Singleton
Fig 6 Memorial to Canon Tinling
Fig 7 Memorial of Snowdrop Marble to Charles Rudhall