# England's Heritage in Stone

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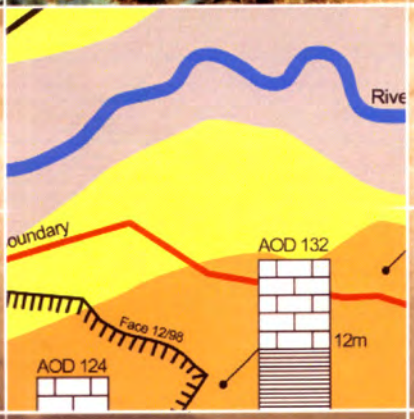


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# Vernacular slate and stone roofs in England

TERRY HUGHES

The vernacular slate and stone roofs of England have used a very wide variety of fissile or cleavable rocks ranging in age from Cambrian to Cretaceous. The physical and visual characteristics of these stones and the skill and ingenuity of roof slaters in adapting them to a range of weather conditions have made a major contribution to England's built heritage and regional distinctiveness. Supply from the larger slate quarries, even in the face of increasing cheap imports from Asia and South America, is secure in the short term. At the small-scale end of the industry – mainly sandstones and limestones – the efforts to support and revitalise the quarries on which the conservation of these roofs depends have had considerable success, but their future is by no means secure.

The use of slate and stone for roofing varies both locally and regionally. The variety of rocks which have been used and the techniques slaters have developed to provide a weather-proof roof in response to local conditions are the keys to understanding how this distinctiveness has come about. Vernacular slates and stone-slates are rough textured, thick and made in a mixture of random sizes, which are arranged on the roof with the longest at the eaves and gradually reducing in length to the ridge. In contrast, non-vernacular or 'modern' slates, the products of very large quarries which were able to split slates as thinly as four millimetres and to segregate them into single sizes, make a very regular and smooth roof. Because of the random nature of vernacular slates or stone-slates, roofs are always steep and therefore they are a dominant feature of a building.

## TERMINOLOGY

Slate. In roofing, the term 'slate' has a much wider use than the strict geological meaning, which is restricted to metamorphic rocks. It is commonly used for any roofing products that are approximately rectangular and flat no matter what they are made of. Also, sandstones and limestones are variously known as slates or grey slates as well as tiles, flags, slabs, tilestones, thackslates and healstones. To reduce the confusion this creates and to distinguish between the two main types metamorphic (cleavable), and sedimentary or igneous (fissile) 'slates', in this paper, the term slate is used for the former and stone-slates for the latter. One exception is made for the stone-slates quarried from the Tilestones Formation between Llandybie in South Wales and Ludlow. In deference to Murchison who coined the name and described its occurrence in *The Silurian System* (pp. 181–3), they are called the Tilestones.

**Delph.** The public perception of quarries has become a considerable handicap when trying to open very small roofing quarries. To try to overcome this problem the words delph or delve have been adopted to distinguish them from large-scale operations.

**Vernacular.** A strict application of the term 'vernacular' to slate or stone roofs would be restricted to their use very close to their source. A distance largely determined by the economics of transportation. This is undoubtedly the case for stone-slates but for metamorphic slates this paper adopts a wider geographical basis. The reason for this is that in most slate quarries manufacture evolved from the random sized, vernacular or 'pre-industrial' product to a single sized, industrial format. Slates of this type were widely promoted and sold and this also resulted in random slates being used far beyond their vernacular boundaries. Because they retained their vernacular character and methods of slating, wherever they were used they are included here.


**Fig. 1.** *Roofing slates used in England have predominantly been sourced from the Cambrian, Ordovician, Silurian and Devonian age rocks in the western parts of England and Wales. One other important source was at Swithland in Leicestershire. Adapted with permission from Cameron et al., BGS*

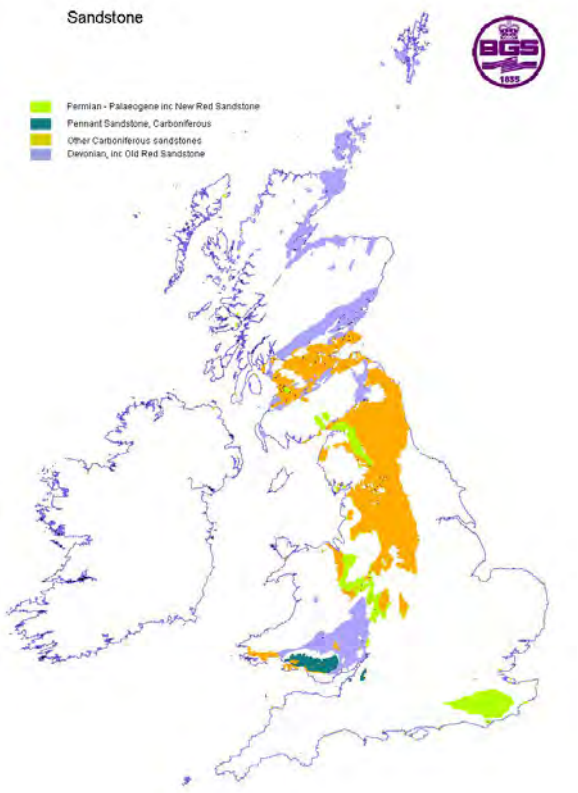


**Fig. 2.** *In the main, sandstones have been used for roofing in the more westerly counties of England from Bristol northwards. In the southeast, Horsham stone is an important source. Adapted with permission from Cameron et al., BGS*

## GEOLOGY

A very wide variety of fissile or cleavable rocks ranging in age from Cambrian to Cretaceous have been used for roofing. Historically, the scale of operations in roofing slates and stones was entirely dependent on the local market. In sparsely populated areas delves were always small especially in the face of the cost of transporting the heavy product over poor roads. Many existed only to supply a single village or farmstead. In contrast, where there was a larger demand reasonably close by and especially if there was a natural means of transport such as a navigable river, some delving centres developed into substantial operations from an early date. By the time of the growth of industrial towns, these became very large indeed.

The metamorphic slates are, with one exception, located in the western parts of England (Fig.1). The exception is the Swithland slate of Leicestershire. Most roofing sandstones are found along a broad line from the Bristol area to Shropshire; in Lancashire; Cumbria; each of the Pennine counties and in Sussex (Fig. 2). The roofing limestones are mainly located along a line from Dorset northeastwards to Northamptonshire and in North Yorkshire (Fig. 3). Although they occur in the classic limestone formations many if not most, are sandy stones. Indeed, over the whole of the formations worked for roofing stones there is an almost imperceptible gradation from sandstones through calcareous sandstones and sandy limestones to limestones.


**Fig. 3** *Jurassic age limestones are a major source of stone-slates to the east of the sandstone sources. Permian age Magnesian limestone has also been used in the past. Adapted with permission from Cameron et al. BGS*

**Cambrian** Geologically, the oldest English roofing stone is the Swithland Slate (Swithland Formation, early Cambrian) quarried near Leicester and used in the surrounding counties (Fig. 4). The quarries around Swithland village and Groby Park worked true slates but in the Woodhouse Eaves area the rock is a volcaniclastic siltstone with a more uneven cleavage.

**Fig. 4.** *The Swithland slates of Leicestershire produce distinctive roofs which cannot be accurately conserved because production ceased in the early nineteenth century. Photo: Terry Hughes*

Swithland slates were produced in three colours: purple, grey and grey-green. Their surfaces tend to be rougher than slates from other regions and they were often used with narrower widths than modern slates, giving roofs a distinctive appearance. They have not been produced since 1887 and had been in decline for a long period before this because of competition from Welsh slates transported via canals and railways. Ironically one of the last major Swithland roofs, which was intended to be a showpiece for East Midland's industry in London, was the Midland Railway station and hotel (St Pancras) commenced in 1866. The grey-green slates for the hotel roof came from Groby Park, Leicester and were delivered along the Regent's canal but, by the time the engine shed was constructed from 1866–68, the Midland Railway Company had decided to use cheaper and lighter Welsh slates. During the re-roofing of the hotel in the early 1990s Westmorland Green slate from Elterwater quarry was chosen as the closest match for the Groby Park slate.

**Fig. 5.** *The Welsh slate quarries have had a major influence on the roofscape of England. This example of Cambrian age 'pre-industrial' roofing slates pegged into turfs over oak wattling is from near Caernarfon in Gwynedd. Photo: Terry Hughes*

**Fig. 6.** *Ordovician age slates near Corwen in North Wales. Vernacular slates and stone-slates are random sized and are arranged on the roof with diminishing lengths up the roof slope. Photo: Clwyd County Borough Council.*

Today, when there is a need to conserve purple Swithland roofs, Penrhyn Welsh slate of Cambrian age is the first choice. However, because of Swithland slate's uneven cleavage and narrowness, it is not satisfactory for conservation purposes to simply choose a mix of standard sizes from this quarry. At best these will give an inadequate mix of sizes

**Fig. 7.** *Technical developments in Welsh slate production changed the product from random to single sizes. This coincided with improved access to the English market. Consequently most Welsh slate roofs in England do not have the appearance of the vernacular roofs close to the quarries. Photo: McAlpine Slate Ltd*

and they may be generally too wide. It is always necessary to develop a specification that includes these characteristics. Although Swithlands are the only Cambrian slates which have been worked in England the blue and purple slates from the west of Gwynedd (Fig. 5) together with the grey slates of Ordovician age to the east (Fig. 6) have had a huge influence on England's roofscape. Close to these quarries, pre-industrial or vernacular slates are random sized in a variety of length ranges – some quite large. In England however, because of the increase in the size of the Welsh industry (Fig. 7), and the rapid development of manufacturing techniques which coincided with easier access to the English market along canals and railways, most roofs of Welsh slate do not have this vernacular appearance. The majority are single sized or large randoms designed to emulate the sandstone-slates of Lancashire and Yorkshire.

**Ordovician** The green Cumbrian slates (Fig. 8) formed during the Ordovician period are quarried in the Lake District National Park at Kirkstone, Coniston, Elterwater and Honister. They are all available in the traditional random formats. These distinctive roofs are therefore secure. However, the economic viability of these and the similar Burlington Blue slates, in part depends upon the production of dimension slate, mainly as cladding and flooring, for modern buildings in the UK and abroad. This is an important issue for any quarry or small delph. It is often proposed that quarrying operations in environmentally sensitive or other protected areas should be limited to the production of traditional products or that their use should be restricted to the local area – within a National Park for example. But limiting an operation in this way will have serious consequences for the viability of the company. This problem would be particularly acute for a roofing delph because the material and labour costs of stone roofs are both very high. The conservation of stone roofs in England is already dependent on grant support from various sources and this support is not without limit. Any increase in the cost of materials can only result in fewer roofs being conserved. Also it is almost always the case that some stone unsuitable for roofing will arise naturally during delving. It makes good economic and environmental sense to take advantage of this to produce walling stone, kerbs, flagging, etc.

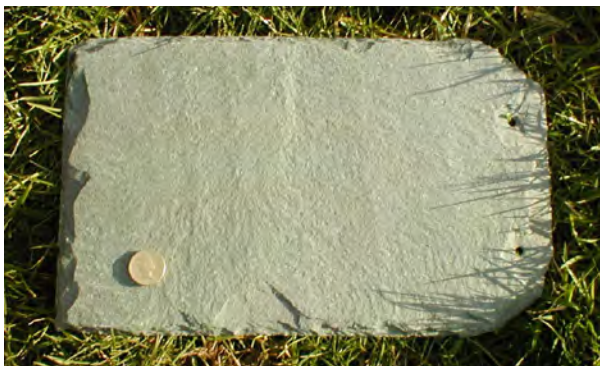

**Fig. 8.** *Westmorland Green slates are traditionally random sized. This 'vernacular' style was used throughout England on prestigious or commercially important buildings. Photo: Terry Hughes.*

**Fig. 9.** *The Ingleton slates from the Yorkshire Dales National Park had a purely local use. Long unavailable, the Park authority is trying to re-establish production. Photo: Terry Hughes*

In what is now the Yorkshire Dales National Park the grey-green Ingleton Slate (Fig. 9) was formerly worked for roofing. Some roofs still remain but, because there are currently no operating quarries, they are generally repaired or replaced with other stone or slate types. The Yorkshire Dales National Park has undertaken research with the intention of trying to re-establish production on a small scale (Carlisle).

At the northern end of the Welsh Marches a variety of Ordovician age stones have been used for roofing. They include the Cheney Longville Flags, the *alternata* Limestone, Harnage Stone from the Hoar Edge Grit Formation; the Cefn Einion Formation and the Chatwall Flags (Chatwall Sandstone) (Fig. 10). Most of these are similar in appearance and may have been substituted for each other during successive roof renewals. Only one, which is visually dis-


**Fig. 10.** *In South Shropshire, a variety of sandstones from Ordovician and Silurian formations were formerly worked for roofing on a small scale. Except for Harnage stone, none are available today. Photo: Terry Hughes*

**Fig. 11.** *Harnage stone-slates from near Acton Burnell in Shropshire were delved specifically to renew part of one roof. This established a source and method for conserving roofs, which represents too small a market to justify a permanent operation. Photo: Terry Hughes*

tinct from the others, has been delved in recent years. This is the Hoar Edge Grit from Harnage about five miles south of Shrewsbury. Known as Harnage Slate (Fig. 11) this very unpromising roofing material was produced to renew the nave of Pitchford Church during 1998 (Wood & Hughes 2003). This work involved researching the geology and the historic quarrying record; walking the ground to identify the old quarries; trial excavations of un-worked ground;

**Fig. 12.** *The Harnage stone-slate roof of Pitchford Church in Shropshire. When slate or stone-slate production is being re-established, it is essential that a detailed specification for the product should be agreed with the delph operator. It should be based on a clear understanding of local tradition and cover criteria such as shape, size, shouldering, surface and edge dressing. Photo: English Heritage*

and the appointment of a Cotswold stone-slate producer to obtain and make the stone-slates. It demonstrated that with a willing landowner; a supportive county planning authority; a sensible attitude to the environmental impact – the stone was quarried in a listed park; and an entrepreneur willing to accept the financial risk of failure – English Heritage which part funded the work; it is possible to save roofs which represent a very small market: perhaps one roof per decade. The project also involved the careful stripping of the existing roof to determine why it had failed after only 50 years – solid bedding in cement mortar was mainly to blame – and drawing up a specification for the new stone-slates to ensure they had an authentic appearance in spite of the use of modern manufacturing methods (Fig. 12).

There is one other Ordovician roofing stone in the region. This was quarried on Corndon Hill near Welshpool (Fig. 13). It has been described previously as a close-jointed, quartz dolerite but is now believed to be altered Hope Shale; a very finely laminated siliceous siltstone. It is no longer quarried and most Corndon roofs have disappeared or only contain remnants of these stone-slates.

**Fig. 13.** *Near Bishop's Castle in Shropshire, the altered Hope Shale was a minor source of stone-slates from at least the fifteenth century. Few examples remain. Photo: Terry Hughes*

**Silurian** In the same area of South Shropshire, Silurian slates and stones have been used for roofing. The slates which are grey and random sized originate in part from just over the Welsh Border; from the Glyn Ceiriog and Tanant Valleys and from near Llangollen. There are no operating roofing slate quarries in the region today. Because of this roofs are repaired with reclaimed slates, which is generally undesirable, or with single sized Cambrian or Ordovician Welsh slates, which radically changes the roofs' appearance. In principle there is no reason why the modern quarries cannot produce slates similar in appearance and in an authentic mix of random sizes.

Along a narrow strip at the junction of the Silurian and the Devonian the Tilestones crop out. These finely laminated reddish or grey-green, micaceous quartzose sandstones (Fig. 14) have been used for roofing from Ludlow in Shropshire, around Downton Castle, through Kingston, Gladestry and Huntington Hill to Clyro Hill in Herefordshire. Westward into Wales they have been exploited around Builth Wells, across Mynydd Eppynt and

**Fig. 14.** *The Tilestones from the top of the Silurian succession have been used for roofs from Llandybie in South Wales to Downton Castle in Shropshire. Photo: Terry Hughes*

near Llandeilo. In appearance they are very similar to some of the Old Red Sandstones and Ordovician stones worked elsewhere in Herefordshire and Shropshire. There are no working Tilestone quarries at present.

In Cumbria, the Silurian age Burlington Blue slates (Fig. 15) are quarried for roofing in a variety of formats, some vernacular, some less so. Provided care is taken in selecting the appropriate format for the roof in question there is little difficulty in conserving these blue-grey roofs anywhere in the country. Special care should be taken to ensure the range of random lengths and widths matches the original roof.

Around Horton in Ribblesdale, the Horton Flags (Horton Formation) were formerly worked for roofing in what is now the Yorkshire Dales National Park. Carlisle has reviewed the potential for re-establishing production.

**Fig. 15.** *The Burlington Blue Grey slates are an important roofing material regionally and nationally. Provided care is taken with the specification, there is no difficulty in conserving these roofs. Photo: Terry Hughes*

**Old Red Sandstone** Over much of Herefordshire and within the Forest of Dean, Silurian and Devonian age stone-slates have been quarried in small shallow delphs.

**Fig. 16**. *A number of formations in the Old Red Sandstone in Herefordshire have been sources of stone-slates in a variety of colours from grey-green to red. Originally, roofs would have almost always been a single colour reflecting the nearest delph. Because of the decline of the industry many roofs are now a mix of differently coloured stone cannibalised from a variety of buildings. Photo: Terry Hughes*

They are fine-grained, micaceous and some are slightly calcareous (Fig. 16). The colour is variable from grey-green, through pink and red to purple. It is likely that originally roofs would have been a single colour reflecting the nearest source but today, due to repairs using reclaimed stone they are often multicoloured. Until recently there were no roofing quarries in the region but as a result of a community initiative to source stone-slates for repairs to Dore Abbey (Fig. 17), a grade one listed building and the parish church, a number of small delves were re-activated or opened. This initiative benefited from help provided by English Heritage (grant aid to the church and funding for technical and commercial advice to potential delph operators) and very positive support from Herefordshire County Council building conservation and mineral planning officers. The local planning policy of consenting small areas – about 0.10 hectare – initially, but then quickly giving permission for extensions in area and time once the delph has proved successful and, most importantly, has been responsibly operated, does much to reassure public fears about such developments. This initiative has been a considerable success but is now threatened by imports of similar but cheaper stone-slates from India. It is argued that the latter's use prevents the loss of stone slate roofs, which, because of the cost of the local product, would otherwise go to concrete imitations. There is some virtue in this of course, but inevitably their lower price weakens the viability of the local delves and means

that ultimately authentic roofs will be largely restricted to those with grant aid.


**Fig. 17** *Old Red Sandstone on the roof of Dore Abbey (Herefordshire) during archaeological recording of the construction. A local initiative to obtain new stone-slates to repair the roof resulted in the establishment of three small delves. Photo: Terry Hughes*

**Devonian** Devonian age slates have been extensively worked in Devon, Cornwall and north Somerset (Fig. 18). Although all the earliest vernacular roofs were random sized, the variety of sources resulted in considerable variation of appearance. As a result of developments in slate manufacturing many old roofs are now slated with single sizes. Although slates were worked in quarries in the Lower and Middle Devonian in the past, today, they are only available from the Upper Devonian from quarries at Delabole and Trevillet near Tintagel and occasionally from Mill Hill near Tavistock. Increasingly imported slates, predominantly from Spain and South America, are being used for new roofs and, to some extent, for the repair or replacement of old ones.

Some special roofing techniques such as scantle and rag slating (see below) are still actively conserved in the region although not always completely accurately. One problem is that the slate sizes used in these methods do not necessarily match the standard sizes produced today. It is very important that the conservation of these roofs should always include a detailed specification for the slate's sizes as well as the specific constructional techniques involved. Given sufficient warning the quarries are usually willing and able to produce what is needed.

**Fig. 18.** *Traditional, Old Delabole slates like those on the right side of this roof are often replaced by slates of a different format and/or from other sources. In this example, small, random, Cornish slates have been replaced with large, single sized, Brazilian. Where conservation is important, it is essential to ensure the correct format is selected (small, random, etc) as well as the traditional source. Photo: English Heritage*

**Carboniferous** The thin fissile sandstones of Carboniferous age represent the largest use of stone (as distinct from slate) for roofing in England. A very large number of rock units were quarried, even some of those commonly regarded as purely dimension stone sources (Hughes 2003). Around Bristol and Yate and across the South Wales Coalfield the Pennant sandstones (Coal Measures Group) (Fig. 19) were worked and the Millstone Grit and Coal Measures groups produced roofing in Lancashire; in and around all the Pennine counties from North Staffordshire

**Fig. 19.** *Carboniferous, Pennant Sandstone roof of St Brievals Castle in the Forest of Dean. This formation in the Coal Measures Group has been worked for roofing here, around Bristol and the South Wales Coalfield. Photo: Terry Hughes*

**Fig. 20.** *A Carboniferous age sandstone roof in Derbyshire. The Millstone Grit and Coal Measures groups produced roofing throughout the uplands of northern England. In the Lancashire – Yorkshire industrial belt, together with production of flagstones for flooring, this developed into a major industry in the nineteenth century. Photo: Terry Hughes*

to Northumberland; and in Cumbria (Fig. 20). Production of these, together with the production of flags for factory

**Fig. 21.** *Stone-slates from the majority of Carboniferous sandstone sources are flat and featureless. Some however, like this roof at Freebirch in Derbyshire, are more textured. At these delves it was common to dress off the rippled texture to allow them to lay well on the roof. Photo: Terry Hughes.*

flooring and street paving, developed into an industry of national importance in the Lancashire – Yorkshire industrial belt during the nineteenth century. In general Carboniferous stone-slates are a variety of grey or brown shades although some are quite red: those from Yate or Iron Acton for example. Typically these roofs are made up of large flat and featureless stones, although there are many which are highly textured - the ripple-marked surface of Freebirch stone (Fig. 21) from near Chesterfield for example - or small, such as those from near Eyam in the Peak District National Park. Ultimately, all these roofs attain a similar colour as a result of particle deposition or plant growth. With the exception of a few small permanent quarries in South Wales, near Keld in the Yorkshire Dales, at Alston in Cumbria, Barnard Castle in County Durham and at Ladycross in Northumberland, supplies of new Carboniferous stone-slates are fitful at best, often dependent on intermittent production from dimension stone sources or very small transient operations. There is some potential for this to improve. Two quarries at Eyam and at Freebirch have been opened recently and the Yorkshire Dales National Park has tried to encourage more delves to open. But if authentic supplies for conservation are to be secured it needs to happen quickly. Already, in the face of uncertain supply from UK quarries and the declining availability of reclaimed material, imports of cheap stone, mainly from India, are rapidly increasing.

**Permian and Triassic** Permian and Triassic stones have not been a large-scale source of roofing. The most important and most distinctive are those from the red Penrith Sandstone Formation of the Eden Valley (Fig. 22). Although there has been no production of roofing stone for years there are still many roofs to be seen. Similar stone has provided diamond pattern slating in Dumfriesshire near Thornhill (Fig. 23). All these localities have active dimension stone quarries and recently a cross-border joint initiative has been instigated re-establish production.

The Magnesian Limestone (Cadeby Formation) has in the past produced roofing very similar in appearance to Cotswold stone-slates (Fig. 24). A few roofs still remain in Nottinghamshire west of Worksop, at Whitwell, Steetley

**Fig. 22.** *In the Eden Valley of Cumbria distinctive red roofing stone was worked mainly on Lazonby Moor. There is an urgent need for a source of these stone-slates to be re-established to conserve these roofs and those from the same stone in Dumfriesshire. Photo: Terry Hughes.*

**Fig. 23.** *In Dumfriesshire, the Permian age red sandstone, similar to that of the Eden Valley in Cumbria, has been used for an ancient roofing style: diamond pattern slating. This was the way Roman stone or slate roofs were constructed. Photo: Terry Hughes*

**Fig. 24.** *A few Magnesian Limestone (Cadeby Formation) roofs have been identified in Nottinghamshire near Worksop. It is believed that in the past it was used over a much larger area. Today there as so few remaining roofs there is little prospect of re-establishing production. Photo: Terry Hughes*

and Barlborough and there is evidence that this stone was used for roofing over a much larger area. There is little prospect of re-establishing production because the market is so small and in the future roof conservation may be forced to use the similar Cotswold stone-slates.

In the Tarporely Siltstone Formation in Shropshire, the

highest beds – the Grinshill Flagstones in the Grinshill-Clive group of quarries – are thinly fissile and are believed to have been used for roofs although none are known to have survived.

**Jurassic** Jurassic stone has provided roofs from Purbeck in Dorset to North Yorkshire. Many different formations have been worked but the most commonly encountered type is Forest Marble (Fig. 25). Roofs of this stone can be seen throughout Dorset, Somerset, Wiltshire, Gloucestershire and Oxfordshire. Because of the intermittent production of limestone roofing generally, Forest Marble has often been used as a replacement for other stones. Conversely other stones (including sandstones) have sometimes been substituted for Forest Marble. The present state of limestone roofs especially in the Cotswolds and surrounding region is quite complex with replacement stone-slates being sourced way beyond their 'natural' region of use. From an early date Stonesfield slates for example, were removed from buildings around the mines for roofing or re-roofing Oxford colleges.

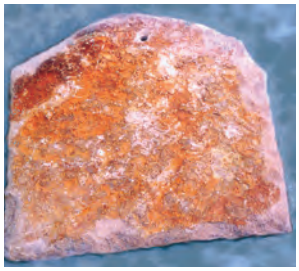

**Fig. 25.** *Many Jurassic formations have been worked for roofing. Forest Marble is the most important and has been used from Dorset to Oxfordshire. Today there are two Forest Marble delphs, one in North Wiltshire and one in Gloucestershire and several working stone in other formations near Andoversford and Naunton in Gloucestershire. Photo: Terry Hughes*

**Lower Jurassic, the Lias Group** Ham Hill Stone (Ham Hill Limestone Member, Bridport Sand Formation) has a very long history of use as roofing but in recent years the active quarries have not been working the fissile beds. This has meant that this roofing stone has often been re-

**Fig. 26.** *The ancient delves on Ham Hill in Somerset produced roofing stone from surface beds. They produced distinctive roofs but because production of roofing ceased many years ago, most roofs now also include Purbeck or Forest Marble stone-slates. The latter are rougher than the Ham Hill Stone which were usually surface dressed. Photo: Terry Hughes*

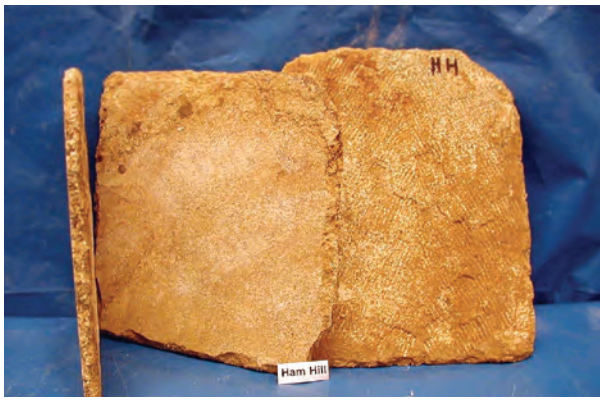


**Fig. 27.** *To overcome the lack of new Ham Hill stone-slates a trial is being run by the National Trust on slates produced by sawing them from stone from masonry beds. They were tested for frost resistance, and strength and are now undergoing long-term assessment on a small roof at a National Trust property. Photo: Sheffield Hallam University*

placed with Purbeck or Forest Marble limestones and even occasionally with sandstones. A recent initiative supported by the National Trust and English Heritage may solve this problem. Historically, the rougher areas of these stone-slates were dressed off so that they would sit well with adjacent slates on the roof (Fig. 26). Advantage has been taken of this feature by sawing slate thicknesses from dimension stone and dressing the surface and edges to give a traditional appearance (Fig. 27). Visually this has been successful. Trial pieces were tested for frost resistance, strength etc. and have now been installed on a small roof at a National Trust property for assessment over an extended period.

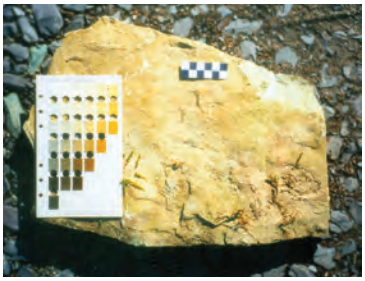

**Fig. 28.** *Lias limestone appears to have been used over a wider area than the evidence of existing roofs indicates. Thin pieces of stone suitable for roofing were discovered in field walls near Ashelworth tithe barn in Gloucestershire. Geological records describe how thin flags were quarried along the Severn from here to Tewksbury but do not specify whether they were for roofing or flooring. Photo: Terry Hughes*

Lias limestone has also provided roofing stone at Chacombe near Banbury and it is possible that there were sources elsewhere in the past but hard evidence is needed to confirm this. Thin stone-slates have been produced near Queen Camel in Somerset (Woodward) but the only evidence is an example excavated from a Roman site (Hugh Prudden pers. comm.). The absence of Lias stone roofs in the area today may be because they were not very durable.

In Gloucestershire, during the recent re-roofing of Ashleworth tithe barn, thinly split Lias limestone was found in field walls (Fig. 28). Thin stone in walls is often an indicator of former roofing production and. possible sources

existed along the River Severn to Tewksbury. Murchison (p 23) also reported that Lias limestone had been quarried for slating purposes in Cheshire by Lord Combermere. This might have been at Burley Dam east of Whitchurch but there is no evidence of it has been found to date. The extent to which Lias limestone has been a roofing source is a considerable mystery and any help in solving it would be appreciated by the author.

**Inferior Oolite and Great Oolite groups** In the Cotswolds all roofing stones are classified as either presents or pendle. The former being quarried more or less naturally 'pre-split' whereas the latter are exposed to frosting to initiate splitting.

Frost splitting, which produces a thinner stone-slate than presents, was formerly carried out at Stonesfield near Oxford (Great Oolite Group) (Fig 29); in the Taynton Stone (Taynton Limestone Formation, Great Oolite Group) from Burford to Enstone and at Soundborough; in the Trougham Tilestone Formation (Great Oolite Group) at Trougham; and at Collyweston (Lincolnshire Limestone Formation, Inferior Oolite Group) in Northamptonshire. Production of frosted slates had ceased in the Cotswolds region by the first decade of the twentieth century and has only continued fitfully at Collyweston. Regrettably, in recent years, the conservation of frost-split roofs has mainly depended on reclaimed material or using the thicker presents.

**Fig. 29.** *At Stonesfield in Oxfordshire, Middle Jurassic pendle stone was frost split to produce thinner slates than presents such as those from the Forest Marble. The very thin frosted slates were desirable because of their lightness and have consequently been removed from local roofs for use on other buildings since at least the middle of the nineteenth century. Photo: Terry Hughes.*

A detailed list of sources of presents is included in Hughes. Not all of these sources are still worked but generally the supply situation for presents is quite good. Several quarries are active in North Wiltshire, at Naunton and near Andoversford and, although production levels tend to wax and wane, it is often possible to specify the geologically correct stone for conservation work. Where complete geological authenticity is not possible, within the presents group, a distinction should always be drawn between Forest Marble (Forest Marble Formation, Great Oolite Group) and other

**Fig. 30.** *A typical limestone roof near Stamford in Lincolnshire. The small sizes of these random sized Collyweston slates can be easily laid to raking intersections and curves making it easier to construct hips, valleys and small dormer roofs. Photo: Terry Hughes*

**Fig. 31.** *The lack of new Collyweston slates has posed a serious problem for the conservation of buildings in the East Midlands and elsewhere for many years. It is hoped that the urgent need to substantially re-slate the roof of Apethorpe House will be the stimulus to re-establish production. Photo: English Heritage*

sources as the former are much more unevenly surfaced giving the roofs a distinctive appearance.

In the East Midlands, the Northamptonshire Sand at Duston, the Lincolnshire Limestone Formation (Collyweston Slate); the Rutland Formation, and the Blisworth Limestone have all been sources of roofing material. Except for a small amount of frosted slate (mainly made from stone taken from the bottom of an aggregate quarry near Collyweston (Fig. 30), there has been no production in this area for very many years. Attempts to re-establish production based on an artificial frosting process have received a stimulus from the need to re-roof the grade one listed Apethorpe Hall (Fig. 31) in Northamptonshire which is being compulsorily purchased by the Department of Culture, Media and Sport. Production is expected to start in 2006.

In North Yorkshire around the southwest of the North York Moors limestone roofing was formerly produced at Brandsby. This appear to have ceased due to competition taking advantage of developing transport systems in the late nineteenth century. There is no production today although the old delves are being researched by the Ryedale (North

and East Yorkshire) Vernacular Building Materials Research Group with a view to small scale production.

**Upper Jurassic and Cretaceous** Close to Brandsby in the Hambleton Hills, Upper Jurassic stone-slates were produced on Boltby and Scawton Moors.

The Purbeck Limestone Group (Lulworth and Durlston Formations) has been used for roofing in the Isles of Purbeck (Fig. 32) and Portland (in the latter from the Lower Purbeck Slatt beds); the Vale of Wardour and in Swindon. Roofing production continues only on the Isle of Purbeck at a modest level and there are often problems because the quarries, which produce a variety of stone products from a range of beds, cannot easily match production to the fluctuating demand. Some quarries are producing roofing slates sawn from non-fissile stone but even the best of these, which are surface and edge dressed, are not entirely convincing. If this technique is to be accepted a more sophisticated product specification needs to be agreed between the conservation bodies and the quarries.

**Fig. 32.** *In the Isle of Purbeck there is still a substantial stone-slate industry and generally the roofs are well conserved. Photo: Terry Hughes*

**Fig. 33.** *The conservation of Horsham stone roofs has been under great difficulty since production ceased in the 1930s. Happily a new delph has recently been opened and shows signs of being commercially successful. Photo: English Heritage*

Only one sandstone of Cretaceous age is known to be significant for roofing – the Horsham Flags (Horsham Stone Member, Weald Clay Formation) (Fig. 33) – although it is probable that other stones have been used for roofs in the southeast in the past. One example is the Charlwood slate, a fissile bed thought to be in the Small Paludina limestone. Horsham Flags were used over a surprisingly large area even from an early date, as far afield as London and Dover, and there are many roofs still in existence although often only the front slope remains. Happily, following attempts to re-establish production over many years, a quarry has recently been opened at Broadbridge Heath near Horsham and this shows signs of being commercially successful.

## ROOFING TECHNIQUES

To understand the styles of vernacular slate and stone roofs it is necessary to understand how slating works. Almost all vernacular roofs are made up of a mixture of randomly sized slates or stones fixed with a peg close to the top of the slate and hung over a lath, or with a nail driven into a batten. The slater takes the mixture of slates supplied by the quarry and sorts them into groups of equal length. They are then arranged on the roof with the largest at the eaves, gradually reducing in length to the shortest at the ridge. This is a process requiring experience and judgement to ensure that satisfactory head-laps and side-laps are always achieved (Fig. 34). To reduce the risk of marginal decisions leading to leaks it is very important that roof pitches are steep: certainly never less than is traditional for the particular slate or stone-slate and the location of the building.

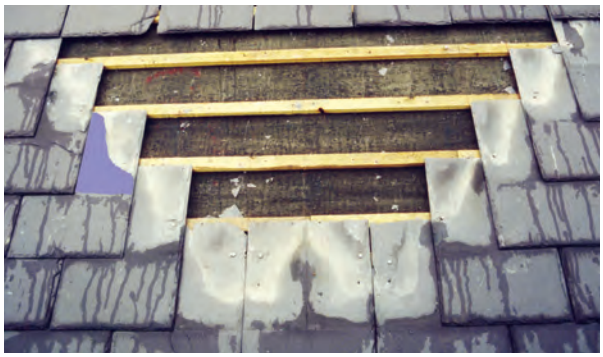

**Fig. 34.** *Slate and stone roofs keep water out by having head and side laps large enough to prevent water passing over the top or round the sides of the slates. The area of water spread between the slates is an inverted T shape. In random sized slating, skill and experience is needed to select and position slates to achieve adequate laps. Photo: Terry Hughes*

**Double lap slating** Slates and stone-slates are always laid in courses with each course vertically overlapping a lower course. Most commonly, course three overlaps course one; course four over course two etc. This is known as double lap slating (Fig 35). The amount of overlap – the headlap – is set in proportion to the weather exposure of the building and the steepness of the roof. The worse the weather the steeper the pitch and/or the bigger the head lap. This prevents water driving up and over the head of each slate or through the peg hole. Additionally water must be prevented

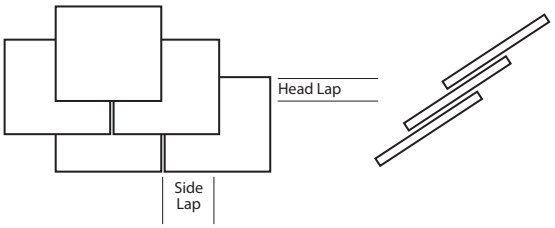


**Fig. 35.** *In double lap slating each course of slates overlaps the course next-but-one below.*

from spreading too far sideways between the slates and over their edges. This is achieved by ensuring an adequate sidelap. In random slating, as work progresses, slates are selected so that the position of the perpendicular joint over the slate below provides at least the minimum sidelap.

**Fig. 36.** *In the South West rag slates are nailed directly to the rafters. The rafters are set closer together than in normal slating but even so some slates are too narrow to lie over two rafters. In this situation they are often fixed with two nails arranged vertically above each other. Photo: Terry Hughes.*

In the West Country there is a system known as rag slating where, the generally wider than normal slates, are fixed directly to rafters without laths or battens (Fig. 36). There are a number of details that need to be respected when conserving these roofs, but otherwise they are essentially normal double lap. Although double lap slating accounts for the majority of roofs there are examples which use single lap (course two overlaps course one, etc.) and triple lap (course four overlaps course one).

**Single lap slating** In single lap slating the arrangement leaves the perpendicular joint open (Fig. 37). To prevent

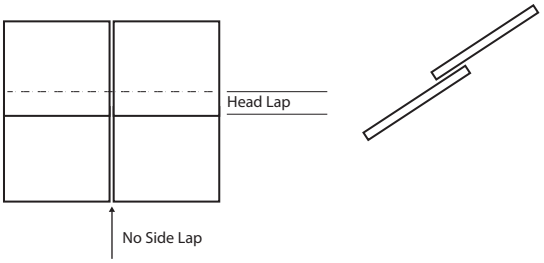


**Fig. 37.** *In single lap slating each course overlaps the course immediately below. This leaves the perpendicular joint open and it has to be protected by some other means such as a slate soaker.*

**Fig. 38.** *In this example of single lap slating on a pigsty, the perpendicular joint is weathered with mortar. More commonly this gap is weathered by bedding a narrow slate over or underneath the joint. Photo: Terry Hughes.*

leaks through this joint, it is weathered by either bedding a narrow strip of slate over it (Fig. 38), usually sealing it with mortar or putty etc. or by setting some form of 'soaker' such as a narrow slate underneath. The head lap is the same as for double lap slating. This is an economical method but only with large slates. Except in Scotland it is largely restricted to agricultural buildings, although a non-vernacular system known as Patent slating has been used. It was often adopted as a modular system to fit metal-framed buildings. A variant of this technique is sometimes used on Horsham Stone roofs in and around Sussex.

**Triple lap slating** Triple lap slating (Fig. 39), known in the West Country as scantle (Fig. 40), appears to have developed to make use of small and sometimes very narrow slates where, for a variety of reasons, good sized slates were

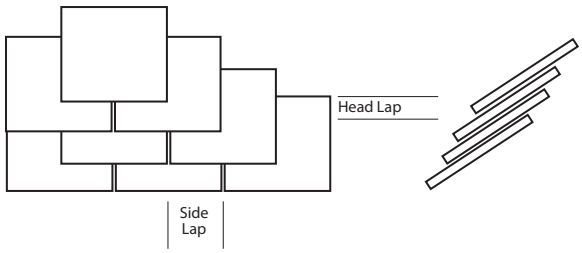


**Fig. 39.** *In the South West (and possibly elsewhere) a triple lap system is used where the fourth course overlaps the first, fifth over second etc. It is believed to have been developed to overcome the narrow laps inherent in using small and narrow slates.*

not available. Narrow slates are prone to leaks because the sidelap is too small but triple lap slating works because the extra layer of slates catches any penetrating water and carries it down to the eaves. It can be regarded as acting like a series of soakers. Because random slates, are top hung they are liable to be lifted by the wind and small thin slates are especially vulnerable. To overcome this problem, in coastal areas of the West Country, scantle slating is commonly bedded in mortar (Fig. 41). An alternative system replaces the vulnerable small slates with large ones at the eaves and verge. This requires considerable skill to bond in the adjacent short slate courses.

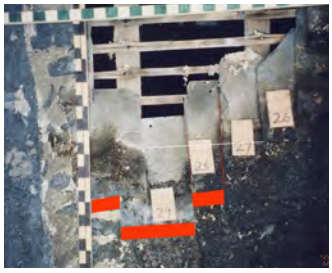

**Fig. 40.** *An example of scantle (triple lap) slating in Devon observed during the archaeological recording of the roof. Because most of the fixing pegs had fallen out, many of the slates had slipped downwards. In the picture the slates in courses 28 and 29 have been digitally repositioned to place the peg holes over the relevant lath to show the original arrangement. The white line shows how course 26 overlaps course 29. (For practical reasons the courses have been numbered from ridge to eaves, the opposite of the normal method). Photo: Terry Hughes*

**Fig. 41**. *In the far west of Cornwall, scantle roofs are typically bedded in mortar. This helps to prevent the small slates being blown off. Photo: Terry Hughes.*

## APPEARANCE

The appearance of slate and stone roofs depends fundamentally on the stones or slates used, the plants that grow on them, the particular slating system employed, and the detailing of the construction. These are the origins of regional distinctiveness.

The general principles of random roofing are that smaller slates require steeper pitches and that smoother slates can be used at lower pitches (or with smaller laps for the same pitch) than rougher ones. Slates and stone-slates can be considered to have two basic forms: large, flat, rectangular sandstones, most prominently those of the Pennines, and Horsham; and the smaller, uneven, limestones and vernacular metamorphic slates. Both of the latter are irregularly shaped at their top edges whereas sandstones tend to be more rectangular. The stones of the Welsh Marches are intermediate in size and metamorphic slates are made in large, intermediate and small sizes. The two extreme types have produced two styles of roof: Broadly, the large sandstone or slate roofs tend to have shallower pitches and simpler planforms (Fig. 42) than limestone and small slate roofs, which are steeper with more complicated forms including raking intersections at dormers, valleys and hips (Fig. 43). Also, small slates or stones can be made to fit around tight curves, which is impossible for larger sizes. This has influenced valley design.

**Fig. 42.** *A typical Pennine roof at Alston in Cumbria. Roofs made from large sandstones are laid at modest roof pitches (around 35–45°) and generally have simple ground plans, avoiding the difficulty of forming junctions at hips and valleys. Photo: Terry Hughes.*

**Fig. 43.** *Roofs made of small slates and stones need to be steep but they can include valleys and hips without difficulty. This example is at Bibury in Gloucestershire. Photo: Terry Hughes.*

**Fig. 44**. *A swept valley in the Cotswold Hills. Sets of slates – usually three and two in alternate courses – are taper cut and laid to form a sweep around the intersection of the roof slopes.*

Valleys are one of the most prominent and important regional features of roofs and should always be conserved. Historically, except where the building owner was willing to accept the cost of lead, stone and slate valleys had to achieve a water-tight junction without soakers. This required con-

**Fig. 45.** *Collyweston slate roofing normally uses laced valleys where a set of lozenge shaped slates are laid up the centre of the valley and the adjacent slates in each course are cut and turned to fit against them. Photo: Terry Hughes.*

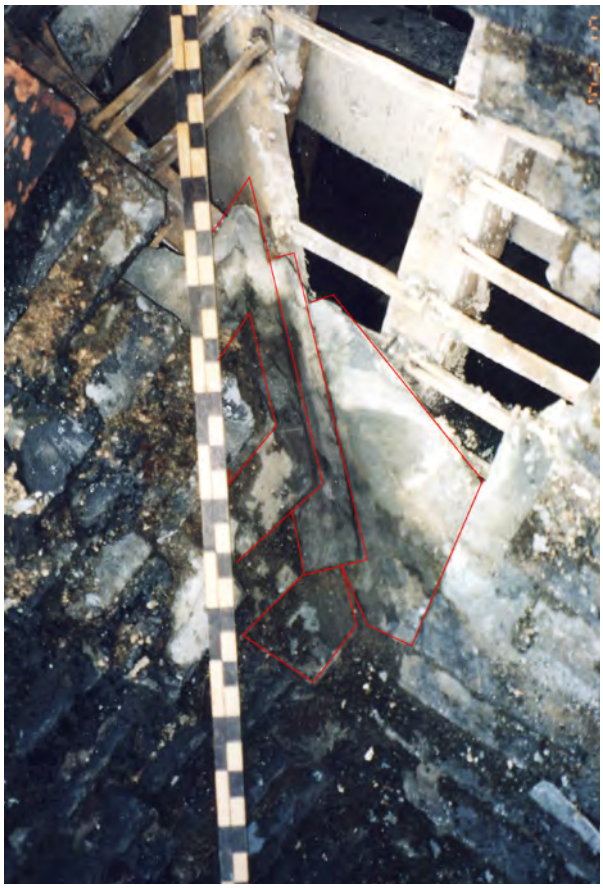

**Fig. 46.** *This valley in a dry laid scantle roof in Devon uses slates that are mitred in alternate courses. In the other courses a very narrow slate is used to break the bond but this produces very narrow side laps. This is only successful because the triple lap system can cope with water that gets past the narrow slates. Photo: Terry Hughes.*

siderable skill and a variety of solutions developed. Swept valleys (Fig. 44) are normally used in the Cotswold region and southwestwards. In these, sets of stone-slates are cut to a tapered shape to allow them to be laid around the intersection of the two slopes in a more or less smooth curve. In contrast Collyweston valleys are laced by cutting the stone-slates alongside the valley so that they can be turned to fit against more or less square slates laid up the valley (Fig. 45).

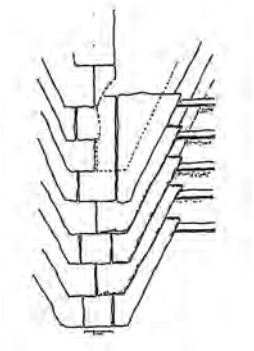

**Fig. 47.** *The arrangement of slates in a dry-laid scantle valley. Note the lapping of courses over the course next but two below.*

A further variant has been found on at least one dry laid scantle roof in Devon. In this slates are mitred in alternate courses. In the other courses a very narrow slate is used to break the bond but this produces very narrow side laps (Figs 46 and 47). These would normally result in leaks but, on scantle roofs, they are watertight because the triple lap system can cope with water that gets past the narrow slates. All of these methods blend the slates across the intersecting slopes without a break in the roof surface.

For the sandstones and slates a different approach is usually taken where the slates in the adjacent slopes overlap onto a set of slates laid up the valley. There are two regional variants of this type: chevron in the Pennines and welsh in Wales and the Marches (Figs 48, 49 and 50). Regrettably these attractive valleys are often replaced with open lead valleys because of a lack of roofing skill.

Regionally, roofs have many other distinctive characteristics such as the style of the stone-slate's edge dressing (Figs 12, 19, 25 and 49) and its orientation, the surface dressing and the use of mortar. These are described in detail in Hughes and examples can be seen at www.stoneroof.org.uk/frame.htm. All of these features should be conserved when repairing roofs.

**Fig. 48.** *Chevron valleys are traditional in the Pennine regions. A row of pointed stone-slates is laid up the valley and the adjacent slates on both sides are chosen or cut to mitre against the valley slate and to provide a half bond with the main slating. Photo: Terry Hughes.*

**Fig. 49.** *In Wales and the Welsh Marches, stone valleys are traditionally constructed by laying a set of stone-slates underneath the slates in the adjacent slopes. These are known as Welsh valleys. Photo: John Goom.*

**Fig. 50.** *Welsh valleys, which would once have been common in Wales and the Welsh Marches, are now rarely seen. This is a weak detail unless constructed with great care and skill and consequently is almost always replaced with an open lead valley. It is preferable to use the original detail but with the inclusion of a lead soaker in every course. Photo: Terry Hughes.*

## THE FUTURE

The short-term future for the conservation of metamorphic slate roofs is secure although the increasing importation of cheaper foreign slates puts this in doubt in the longer term. The UK slate industry would do well to support the careful conservation of roofs as this is the one market that could be secure from competition. In particular, where special sizes or formats of slate are required, they could be more positive in liaising over the product specification and delivery times. For stone-slates, the last 10 years has seen an improvement in supply. New delphs have opened in Herefordshire, Shropshire (Harnage slate at Pitchford, now mothballed pending the next roof to repair), Derbyshire, the Peak Park and Horsham. In other regions the existing industry has benefited from support by conservation organisations and is more economically secure than it was previously. Nonetheless, there are several important stones that still cannot be obtained (except, unfortunately, from other roofs). What are needed to resolve this are sustained, commercially minded, local initiatives; an improved public understanding of the actual rather than the perceived impact of delves; and a rethinking of the way environmental and building conservation legislation can live together. In particular, the development of environmental legislation has outstripped the legislative protection of historic buildings because the latter does not deal adequately with material supply. This is not unique to roofing or even stone. It is not even unique to the UK. Problems of building conservation resulting from loss of sources of building materials are experienced throughout Europe. Happily, there are signs that a better environment may be developing in the UK. In mineral planning guidance, a more positive emphasis is being placed on sourcing stone. English Heritage and English Nature are co-operating to develop a system for balancing the objectives of nature and building conservation and there is much good will in the National Parks and organisations like the National Trust and the Council for the Protection of Rural England to develop a better understanding of the need for stone and slate for conservation and to promote it to their members. But this work needs to progress rapidly. The biggest threat to stone-slate production in the UK is that new delves will not open soon enough and that the market will be irrevocably lost to imports. This would be a bad outcome for both our natural and built heritage. One of the important aspects of UK specialist roofing delves is their small environmental impact. But these products are heavy, and the environmental impact is far larger if substitutes are imported from thousands of miles away.

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