STRATEGIC STONE STUDY

A Building Stone Atlas of Devon

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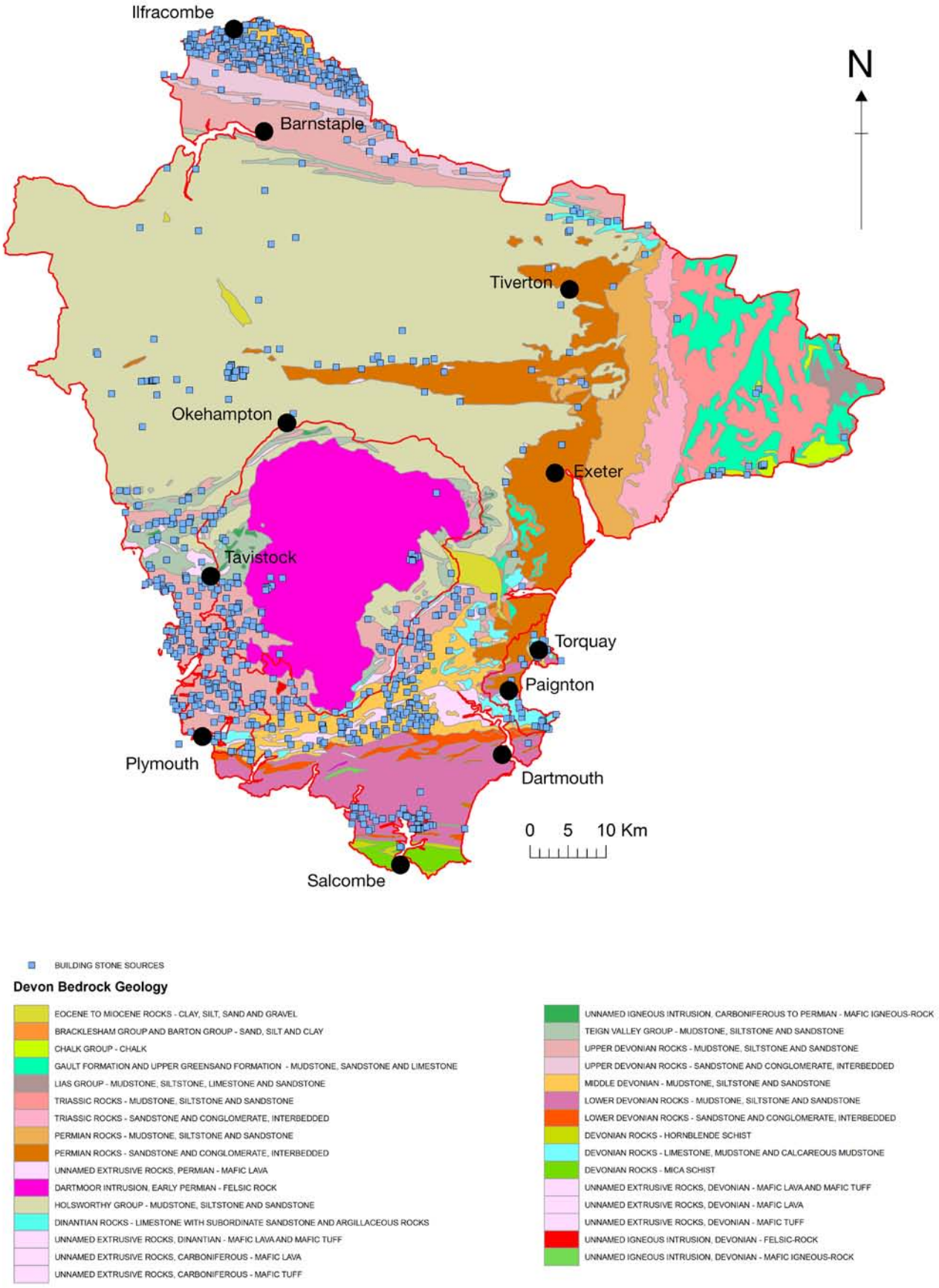
Bedrock Geology Devon



Click on this link to explore the geology of Devon and the area's known building stones, stone structures and building stone quarries (Opens in new window http://maps.bgs.ac.uk/buildingstone?County=Devonshire)

Introduction

The geology of Devon, encompassing some 420 million years of Earth history, is highly varied, and this is reflected in the variety of landscapes present within the county. Rocks dating to the Devonian period are the oldest found at outcrop. These represent a time when the Devon area lay near the equator and was submerged beneath a tropical sea. The sands and muds deposited at this time now form the **SANDSTONES** and slates found in both north and south Devon. In shallow water areas, during the Middle and Upper Devonian, **LIMESTONES** accumulated, which are now exposed around Plymouth, Torquay and Brixham. The lithologically diverse Devonian succession has produced some of the county's most important building stones.

Carboniferous strata (formerly referred to as the 'Culm Measures') occupy large parts of central and northern Devon. The succession comprises thick developments of deep-water, basinal **MUDSTONES**, with thin **INTERBEDDED** sandstones. The end of the Carboniferous was a time of major tectonic upheaval (representing the culmination of the Variscan Orogeny) during which the Devonian and Carboniferous successions were deformed and altered to form the cleaved, slaty rocks that now characterise much of the county.

In the aftermath of the Variscan Orogeny, arid, desert-like conditions became established, under which were deposited the vivid red sandstones, coarse breccias and conglomerates that typify the Permian and Triassic of Devon. The Early Permian also saw significant intrusive and extrusive igneous activity. This produced lava flows and minor igneous intrusions, many of which have become significant sources of local building stone, most notably around Exeter. The substantial Dartmoor Intrusion – a major source of granite for both Devon and regions beyond – was also emplaced at this time.

Tropical seas submerged the area at the end of the Triassic, and this began a long phase of marine sedimentation extending through the Jurassic and into the Cretaceous. Developments of Jurassic strata within Devon are limited to a few isolated outcrops of Lower Jurassic marine limestones, which have provided some local building stone. The rocks of the overlying Cretaceous succession contain several of the most significant building stones of southern and eastern Devon, and include the 'greensand', **CHALK** and flint lithologies.

Mantling the Upper Palaeozoic and Mesozoic rocks of Devon are largely unconsolidated deposits of Quaternary age. These accumulated during a period of climatic instability which saw the advance and retreat of glaciers across Britain. There is no record of these glaciers covering Devon, however, which essentially lay to the south of the ice margins. Permafrost conditions instead prevailed, and a wide range of periglacial features formed.

DEVONIAN

SOUTH DEVON

Devonian Schists

The schistose rocks of south Devon (the oldest in the county) form what is known as the Start Complex. This principally comprises two lithological types: green hornblende-bearing schists (the 'Start Hornblende Schists') and grey mica-bearing schists (the 'Start Mica Schists'). The hornblende schists were formed by the metamorphism of igneous lavas, sills and tuffs, while the mica schists represent metamorphosed sedimentary shales, siltstones and sandstones. The mica schists have a well developed schistosity, particularly when compared to the hornblende schists (which tend to be more massive). Both rock types are poor building materials owing to the combined effects of the schistose fabric, relict bedding and veining, which impart a hackly fracture and make the stones difficult to dress.

These rocks crop out in a roughly E–W-trending belt running between Bolt Tail and Start Point (via Bolt Head, Salcombe and Prawle Point). As a building material, the Start Complex lithologies have only a local significance, and it is the Hornblende Schists which have a greater prominence, being used for vernacular purposes rather than for higher status buildings. The image below is of a cottage in Salcombe, constructed of partly dressed and rubblestone blocks of Start Hornblende Schist.

Devonian 'Slates'

'Slates' occur widely within south Devon, their **OUTCROP** existing as a broad band which extends across the South Hams from Dartmouth to Plymouth.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These 'slates' form the bulk of the Lower Devonian Dartmouth and Meadfoot groups, and represent an important building stone resource for both Devon itself and areas beyond. At stratigraphically higher levels lie the slates of the Nordon, Tavy and Gurrington formations. Slates assigned to the latter formations (which are of Upper Devonian age) have been used for building in the area to the north of Plympton and also around Buckfastleigh.

Dartmouth Group

Dartmouth Slates & Sandstone

The Dartmouth Group is divided into two formations at its western end – the Whitsand Bay and Bin Down formations. The Whitsand Bay Formation (Lochkovian to Pragian in age) is characterized by purple, occasionally green, slaty mudstone with thin variegated sandstone beds, whereas the (Pragian) Bin Down Formation comprises grey slaty mudstone and quartzitic sandstone with interbedded, silicified, basic lava and volcaniclastic rocks. Whitsand Bay Formation lithologies are particularly important from the point of view of building stones, with Dartmouth Parish Church (image above) serving as an example of their use. The slabby nature of most of the material makes it particularly suitable for the construction of walls. The sandstones exhibit a range of sedimentary structures (such as cross-bedding) and are fairly weak and susceptible to weathering; as a result; they are commonly rendered.

Meadfoot Group

‘Meadfoot Slates’

Both the slates and sandstones of the (Pragian to Emsian) Meadfoot Group have seen general use in the construction of walls. The slates have also been used for roofing purposes. Meadfoot Group sandstone is a brownish red colour, while the slates (a cleaved mudstone) are typically grey, weathering to a greenish grey or orange-brown colour. In terms of construction work, the sandstones are fairly strong, but the cleavage in the mudstones renders them fairly weak, creating a need for alternative materials for **QUOINS**. The Dartmoor Union public house in Holbeton (image top right) features Meadfoot Group stone in its walling.

Torbay Group

Nordon (Slate) Formation

The Nordon Slates (of Eifelian to Frasnian age) have been widely used in the area around Totnes, particularly for walling. They are grey when fresh, but weather to an orange cum brownish grey. The slates are interbedded with siltstones, sandstones, tuffs and lavas, and as a result, blocks of these particular lithologies are also seen in the fabrics of buildings.

Tamar Group

Tavy Formation

In the west, the (Frasnian to Famennian) Tavy Formation consists mainly of smooth slates, the cleavage surfaces of which have a greenish chloritic sheen. To the east, around Buckfastleigh, the upper part of the unit comprises greenish grey slates, but the lower part contains purple and green mottled slates. The green Tavy Formation slates are an important building stone resource in Devon. The stone is currently worked at Mill Hill Quarry to the west of Tavistock, where blue-green slates are produced. The image bottom right is of a cottage at Horrabridge which boasts walls of green Tavy Formation slate.

Kate Brook Slate

The Kate Brooke Slate represents a minor slate resource which has been used for not only for sills and occasionally roofing, but also for constructing internal and external walls. It is a fairly distinctive smooth, greyish green slate (weathering yellowish grey) with lustrous cleavage surfaces.

Gurrington Slate Formation (no parent group)

The (Frasnian to Tournaisian) Gurrington Slate Formation crops out in the Ashburton–Buckfastleigh area. Its constituent slates are typically bright green or purple when fresh (weathering black or ochreous brown), but they can be mottled and, in some cases, are poorly foliated. These slates have been used as a general walling stone, sometimes in association with deformed, vesicular, olive-brown lavas and tuffs (some of which are also vesicular and contain broken feldspar phenocrysts).

NORTH DEVON

Hangman Sandstone Formation (no parent group)

Hangman Grits

The outcrop of the distinctive 'Hangman Grits' lies just outside Devon within the Exmoor National Park. These medium-grained, massive to well-bedded sandstones, which, although typically red, show some colour variation from red to purple to grey and greenish grey, occur in 'channelized' beds of up to 4 m in thickness or as sheet-like bodies in units mostly less than 1 m thick. Much of the rest of this Eifelian to Givetian formation comprises reddish brown mudstone. The 'Hangman Grits' are suitable for a variety of uses, but within Devon, these sandstones are encountered only rarely, being used principally for decorative purposes within the fabrics of higher status buildings (e.g. at Tawstock).

Ilfracombe Slates Formation (no parent group)

Combe Martin Slates Member

These Givetian to Frasnian slates saw only limited use within Devon. They are generally well cleaved and grey in colour (weathering a yellowish-brown), but can appear grey or greenish grey or even purple. Thin sandstone and limestone bands are common in the succession, with some limestones thick enough to be quarried; slate production was thus often a secondary concern in some quarries. In spite of the well developed cleavage, the rock appears fairly strong and may have been used for the construction of walls which were subsequently rendered.

Kentisbury Slates Member

The Kentisbury Slates, because of their friable nature, were used to only a limited extent as a roofing material, and were instead largely used for **RUBBLE** walling and hanging tiles. They form part of a mudstone dominated sequence of variably grey, greenish grey and purple rocks, which includes many thin sandstones as well as thin and thick limestones. The presence of bedding, cleavage and joint planes within the various lithologies of this unit makes them generally friable and weak, and their use was restricted to their outcrop area. The quarries opened up within the Kentisbury Member were most likely producing aggregate and a little building stone.

'Ilfracombe Limestones'

The name 'Ilfracombe Limestone' is applied to lenses of limestone occurring within the 'slate' formations of North Devon. These tend to be less thinly bedded than the limestones of the younger Teign Chert Formation (see p.11). They are of a grey-green colour, are ooidal in places and, consistent with their 'slate' interbeds, often show evidence of tectonism. The (Givetian) Jenny Start Limestone, found near Ilfracombe, is probably the best known of the limestones. The 'Ilfracombe Limestones' have generally been used in the North Devon area for wall structures and quoins, principally in churches and other high status buildings. The image below is of the Ilfracombe Church Rooms, built from 'Ilfracombe Limestone'.

Morte Slates Formation (no parent group)

Amongst the Devonian 'slate' units of North Devon, the 'Morte Slate' is the most significant both in terms of its geographical extent and its use as a building stone. This slate has a greenish grey colour, a well developed slaty cleavage (with lustrous sheen on cleavage surfaces) and weathers to a distinctive silvery grey. It is fairly strong, but shows some susceptibility to weathering (particularly frost action). 'Morte Slate' has been used for roofing, wall-hangings, and general construction purposes (especially the more rubbly stone).


© North Devon District Council

In Mortehoe itself, limestone has also been used for structural purposes and for quoins; this was most probably sourced from nearby, given that limestone is locally interbedded with the 'Morte Slates'. The limestone is pale grey and contrasts with the green-grey colour of the Jenny Start (Ilfracombe) limestones. There is only one active quarry, which is owned by the National Trust and provides for their needs. The image below shows cottages at Mortehoe, which are built of 'Morte Slate' rubble. The boundary walls are also of 'Morte Slate', with copings of limestone (collected from the beach).

Pickwell Down Sandstones Formation (no parent group)

The (Famennian) Pickwell Down sandstones are of deltaic origin. They form a near-continuous east–west outcrop running from Morte Bay in the west to Dulverton and the border with Somerset in the east.

The maximum width of the outcrop is about 8 km, and its form suggests large-scale folding in places. The formation consists of consists of purple, red, brown and greenish-grey, fine- to medium-grained sandstone beds, which frequently show current bedding. These sandstones form units up to 3 m thick, although most less than this, and thin micaceous horizons are developed in places. Subordinate interbeds of red and grey shales are locally present, particularly towards the top and bottom of the formation. The actual base of the formation is marked by an occurrence of volcanic rock known as the 'Bittadon Felsite' (or Bittadon Tuff Bed).

The most commonly seen form of 'Pickwell Sandstone' from a building stone point of view is the deep purple variant. This was clearly considered to be a desirable building stone during the C18 and C19, and it has been used structurally and decoratively in the construction of both high status and 'philanthropic' buildings.

Exmoor Group

Baggy Sandstones Formation

This formation, of Famennian age, represents the youngest of the Devonian deltaic sequences. It consists of interbedded fine-grained, grey or green-grey sandstones, siltstones and shales, with thicker buff-coloured, fine-and medium-grained feldspathic and micaceous sandstones in places. Owing to their micaceous nature, the sandstones tend to be thinly bedded and consequently split into slabs bounded by surfaces corresponding to the bedding planes. 'Baggy Sandstone', despite its relatively limited outcrop, has been used widely in both the general vicinity of its extraction and beyond, a-nd is a common building stone in the Barnstaple–Braunton–Georgham–Woolacombe area. It was extracted at the now inactive Plaistow Quarry. The image below shows dressed and coursed blocks of 'Baggy Sandstone' in the Penrose Almshouses, Barnstaple.

Pilton Mudstone Formation

'Pilton Slate'

The Pilton Mudstone Formation is a transitional succession spanning the Devonian–Carboniferous boundary. Lithologically, it comprises a complex sequence of interbedded siltstones and sandstones. In the central part of the outcrop and towards its western end, there are thicker developments of hard, grey, fine-grained sandstone, with interbeds of hard, grey, silty shale, which are currently worked in the Bray Valley. The worked horizons comprise relatively thin interbeds of grey, variably **FLAGGY**, micaceous sandstone and calcareous siltstone, which alternate with thicker beds (generally up to 2 m, or more rarely 4 m, in thickness) of grey, fine- and medium-grained sandstone and hard, dark grey mudstone.

Although there is some record of the use of 'Pilton Slate' in buildings, the more durable Pilton sandstones have seen more extensive use as a local building material and these are still worked at Hearson Quarry for walling, rockery and paving stone.

Limestones

During Middle to Late Devonian times, thick reef limestones accumulated in the south Devon area around Plymouth (Tamar Group) and also around Torquay and Brixham (Torbay Group). The development of these limestones, in particular of the reefs, was closely related to local fault movements, which produced shallower water areas or 'highs'. Subsequent tectonism during the late Carboniferous (Variscan Orogeny) led to the partial metamorphism of these limestones, thereby forming the variegated marbles that have been used extensively for both vernacular building stone and decorative stonework throughout the county and beyond.

The numerous old quarries around Plymouth and Torquay bear testimony to the past importance of the Devon limestone industry. Many of the quarry sites are located close to the shore for ease of shipment, such as those around the Cattewater in Plymouth and those on the headlands bordering Torbay (Hope's Nose and Berry Head). Rough cut stone has seen extensive use in the construction of vernacular buildings but, historically, its most important use has been as dressed and cut stone for public and other important buildings. It has also been used during municipal and civil engineering projects. Slabs of Devonian limestone are still to be seen as paving in the streets of Plymouth, Torquay and, to a lesser extent, Exeter (where it is a significant building stone). Retaining walls and harbour works provide yet further examples of the use of these limestones. Much of the mainline railway which follows the seawall between Teignmouth and Dawlish is faced with blocks of Devonian limestone brought by sea from Torbay.

Chercombe Bridge Limestone Formation (no parent group)

'Ashburton Marble'

This is a highly significant stone, but one which is now quarried only for aggregate within the Dartmoor National Park. It has been used for decorative purposes throughout Devon and beyond. The stone itself (of Eifelian to Givetian age) often boasts spectacular coloured patterns involving veins of white calcite and streaks of red haematite set against various background shades of grey.

This is particularly so in some of the limestones found around Newton Abbot, Buckfastleigh and Ashburton – the so-called 'Ashburton Marble' – which are able to take a hard polish. The image below shows the use of 'Ashburton Marble' as a fireplace surround in the Roborough Room, County Hall. It should be noted that the stone is not a true marble since it has not been subject to the extremes of metamorphic heating, and in this case the fossil corals present are beautifully preserved.

Torbay Group

East Ogwell Limestone & Torquay Limestone formations

'(Pale Grey) Torquay Limestone'

East Ogwell Limestone has a uniform pink colour derived from the presence of haematite. Like the 'Ashburton Marble', East Ogwell Limestone is now a major source of aggregate as opposed to building stone. It is a **FOSSILIFEROUS** limestone which has in the past been used for decorative as well as building purposes.

The image below shows East Ogwell Limestone cottages, Topsham.

There are many different names for the typically pale grey limestones worked around Torquay and which are now assigned to the Torquay Limestone Formation (Givetian to Frasnian). These include the Petitor Limestone, the Walls Hill Limestone, the Babbacombe Limestone and the Lummaton Limestone (the names generally deriving from quarry names). Torquay Limestone is a competent building stone which tends not to spall.

Brixham Limestone Formation

'Mid-Grey Devonian Limestone'

Although paler grey limestones do occur within the Brixham area, the majority quarried from the (Eifelian to Frasnian) Brixham Formation are mid-grey in colour. The most extensive extraction in the past was from around Berry Head. This being a coastal location, it was ideally situated for the 'export' of stone to neighbouring coastal settlements and those accessible by river (such as Exeter).

Like the 'Torquay Limestone', it sometimes contains fragments of tabulate and rugose corals and stromatoporoids, and it can be cross-cut by irregular calcite veins. It also is a competent building stone and tends not to spall upon weathering. Brixham Limestone is also known as Berryhead Limestone, Sharkham Limestone (the Sharkham Point Member) and Goodrington Limestone (the Goodrington Member).

Tamar Group

Plymouth Limestone Formation

The Plymouth Limestone (of Eifelian to Frasnian age) is another massive, pale to mid-grey coloured limestone, although occasionally it is dark grey and well-bedded, with a fine grained calcite (and sometimes clay) matrix. Like the Torbay Group limestones, calcitic veining is often present and they may contain fragments of tabulate and rugose corals and stromatoporoids. The darker coloured variety, with its associated clay layers, is more liable to spall upon weathering.

Volcanic Rocks

Torbay Group

Ashprington Volcanic Formation

The (Eifelian to Frasnian) Ashprington Volcanic Formation principally comprises basalts which have a distinctive dark green colour, weathering purple, red and ochreous yellow. Some of the rocks are porphyritic, giving them a mottled or spotted appearance, and in some places they are vesicular. The Ashprington Volcanics have a fairly limited outcrop to the west of Torbay and south of Totnes, notably around the village of Ashprington itself, where it is a commonly used building stone.

CARBONIFEROUS

Marine shales and sandstones of Carboniferous age underlie much of Devon. Unlike many other parts of Britain where Carboniferous non-marine sandstones, coals and limestones are the dominant rock types, the marine rocks of Devon contain no economic coal or limestone deposits.

Igneous rocks

Milton Abbot Formation (no parent group)

Hurdwick Stone

The Milton Abbot Formation largely comprises accumulations of basaltic lava and volcaniclastic material. This was quarried from small outcrops located to the north and north west of Tavistock, most notably around Hurdwick Farm (from which the name 'Hurdwick Stone' derives). The rock itself has a distinctive pale green colour and often a rough texture due to its vesicular nature. Unfortunately, the stone does not always weather well and tends to break down over a period of time. It has nonetheless been used in Plymouth, and around Milton Abbot, North Brent Tor and as far west as Dunterton, but its most extensive and noteworthy use is around Tavistock, particularly within the World Heritage Site (image below). The stone was used for the early C19 buildings in the planned townscape created by the Bedford Estate.

(Meta-)sedimentary rocks

Lydford Formation (no parent group)

Lydford Slates

The Lower Carboniferous Lydford Slates have a localised area of use between Lydford, North Brentor and Chillaton. The slates are dark grey in colour, weathering to a brownish grey, and can be distinguished from other slaty rocks occurring nearby by virtue of their micaceous nature.

Teign Valley Group

Codden Hill Chert Formation

Codden Hill Limestone

The Codden Hill limestones are generally thinly bedded, although some more massive limestones do occur. They have been extensively quarried and there are many examples of their use as a building stone within the area extending from South Molton in the east to Barnstaple in the west, including buildings within the Filleigh Historic Park.

Teign Chert Formation

The Teign Chert Formation includes interbedded **SILICEOUS** mudstone and chert, with local developments of limestone. It is the lensoid bodies of limestone which have principally been exploited as a source of building stone, but these tend to be of limited size and many, for example those at Meldon Pool and Drewsteignton (both in northern Dartmoor), have been worked out. The chert, although hard, is much less suitable as a building stone.

Bampton Limestone & Westleigh Limestone formations

The Lower Carboniferous rocks of north and mid-Devon include relatively thin sequences of limestones which are assigned to the Bampton Limestone and the Westleigh Limestone formations. The former comprises thinly bedded and rather impure limestones, interbedded with chert and mudstone. The more limestone-rich parts of the succession were formerly worked for building stone in the area around Bampton, and the eponymous limestone is a locally significant stone in this area.

It can be distinguished from the Westleigh Limestone by virtue of its banded and thinly bedded nature (which gives rise to thin blockstone).

The Bampton Limestone passes laterally into the Westleigh Limestone, a unit characterised by generally thicker and more abundant limestone beds. At Westleigh Quarry, beds of pale grey, coarse-grained, sparsely fossiliferous limestone ('calcarenite') are developed, with subordinate, mostly thin, inter-beds of mudstone and calcareous mudstone. The individual limestone beds vary in thickness from a few centimetres to 6 metres, and they show lateral persistence across the quarry faces. Each limestone bed has a sharp basal contact with the underlying mudstone, and many show graded bedding and gradational tops into the overlying mudstones. Westleigh Limestone is a building stone of local significance, but due to the lack of other suitable materials, it has been used more recently for repair work and new build projects over a much wider area. The image below is of the facade of the Royal Devon and Exeter Hospital which comprises Westleigh Limestone walling with 'Torquay Limestone' quoins.

Holsworthy Group

Crackington Formation

The Upper Carboniferous Crackington Formation has extensive outcrops in north, central and west Devon. In general, it comprises rhythmically bedded, dark blue-grey mudstones and subordinate mainly grey sandstones and **SILTSTONES**. Individual sandstone beds within the formation show sharp bases with load and groove casts. The sandstones are mostly fine-grained and often fine upwards into siltstone; small-scale cross-bedding is present in some units. In certain areas, towards the base of the formation and also near its top, the sandstone beds coalesce to form units more than a metre thick.

The relatively coarse-grained and the relatively fine-grained lithologies are informally referred to as 'Crackington Sandstone' and 'Crackington Slate', respectively. 'Crackington Slate' tends to be more common in the northern outcrops of the formation. Broadly speaking, the Crackington stones have only been used for walling and dressed stone is not common.

Bideford Formation

The Bideford Formation is a fairly localized development of shallow water sediments which extends inland, in an easterly direction, for some 27 km from the Bideford area. The abundant sandstones of the formation are mostly soft and (in part) feldspathic, and commonly have a saccaroidal texture. Most are fine- to medium-grained, but coarser layers are present, particularly at the bases of individual beds. The sandstones reach 30 m in thickness, but are in general much thinner. They feature cross-bedding, mud flake **CONGLOMERATES**, erosive bases and carbonaceous debris.

The most important building stone yielded by the formation is the Cornborough Stone, a hard, dark grey, well-bedded sandstone, which is finer grained on average than the sandstones of the Bude Formation. Like the Bude sandstones, it is often crudely cleaved with feathered fracture surfaces in the more massive parts. The weathered colour of Cornborough Stone is darker than that of the Bude and Crackington formation sandstones.

Bude Formation

The Bude Formation has an extensive outcrop running from the north Cornwall/north Devon coast between Gull Rock and the southern part of Widemouth Bay eastwards towards Tiverton and the Exe Valley.

Lithologically, the Bude Formation differs from the underlying Crackington Formation due to the local presence of thick beds of rather soft, brown-weathering sandstones called simply Bude or Culm Sandstone. These are typically interbedded with grey or brownish-grey siltstones and mudstones, which are form the predominant 'rough' building stone over the outcrop. They tend to be used for principally for rubble walling and are not suitable for quoins or structural work. Near to the base of the formation are found hard, turbiditic sandstones, which include beds of the Bude Gritstone. This has generally been used for structural work.

Close to the boundary with the overlying Permian rocks, thick beds of brown, reddish-brown, purplish brown and greenish grey or olive-grey, massive, fine- to medium-grained sandstone occur, which, individually, can be up to several metres thick. These have yielded the 'Dark Red Sandstone', 'Hensley Stone', 'Brownstone' and 'Cinnamon-coloured Sandstone', all of which are significant building stones. The image below is of the Church of St Lawrence in Sheepwash, with its 'Bude Dark Red Sandstone' quoins and 'Bude Sandstone' walling.

PERMIAN

Intrusive igneous rocks

Dartmoor Intrusion

Dartmoor Granite

The granite of the Dartmoor Intrusion, in its various textural guises, underlies much of the high moorland of Dartmoor. This body was previously considered to be of Permo-Carboniferous age, but modern radiometric dating and revisions to the Permian–Carboniferous boundary age now place it firmly in the early Permian. The granite formed from molten magma originating several kilometres down in the Earth's crust. This magma gradually penetrated higher crustal levels, then cooled and slowly solidified into the coarsely-crystalline rock exposed at the surface today. It is a hard, strong and durable material, and one which takes a good polish (a characteristic that has led to it being widely used in monuments). The use of Dartmoor Granite as a building stone dates back to Bronze Age times.

Dartmoor Granite is composed principally of large milky-white crystals (phenocrysts) of feldspar, which reach 8cm in length and are rectangular in cross-section, set within a matrix (groundmass) of smaller crystals including **QUARTZ** and dark brown mica. The so-called 'Blue Granites' do not have well developed phenocrysts.

The granite was difficult to work prior to the advent of iron tools, but loose, stone blocks known as 'moorstone' are widely present across the high moorland, and some show clear evidence of attempts at splitting and shaping. In more recent times, the granite has been extensively quarried and it is an important stone not only in the Dartmoor towns such as Chagford, but also features in many churches and high status buildings located outside Dartmoor. Granite from the Haytor quarries was used, in part, to construct the former London Bridge, with much of the rest of the stone seemingly having come from the quarries near Princetown. Quarrying of Dartmoor Granite, once key to the local economy, has progressively reduced over the last century, however, and it is now insignificant. Supplies of Dartmoor Granite for building and restoration work are consequently now limited.

There are three main varieties of Dartmoor Granite. These are known locally as 'Giant Granite', 'Blue Granite' and (its sub-type) 'fine-grained Blue Granite'. The fine-grained variety has been quarried at several locations on Dartmoor, notably at Gunnislake.

Giant Granite

The so-called 'Giant Granite' is a coarse grained, grey granite containing large euhedral feldspar megacrysts (sometimes up to 30 % by volume). Quarried at Haytor, Princetown and Merrivale, principally for use outwith the Dartmoor area (and indeed the county), it was generally considered to be a stone that was more suited to structural work. It does, however, feature prominently within the Tavistock World Heritage Site. The image below is of a café at Princetown, built of 'Giant Granite'.

Blue Granite

The 'Blue Granite', although coarse-grained and mineralogically similar to the 'Giant Granite', contains few or no megacrysts. It is found in the north west of the Dartmoor massif south of Okehampton and in the south west at Shell Top, north east of the China Clay workings.

The 'fine-grained Blue Granite' (or microgranite) was used for fine carved work and is usually seen as window mouldings in churches, schools and higher status buildings. It was also used for monuments. The Swelltor quarries were one of a number of sources of this fine-grained granite.

Dolerite

Spatially associated with the Dartmoor Granite Mass are minor intrusions of dolerite (or microgabbro). A concentration of these intrusions occurs within the Teign Valley. The green-black dolerites of the Teign Valley characteristically develop ochreous crusts and exhibit 'onion-skin weathering'. This weathering process frequently creates 'boulders' of hard residual material, which have, historically, been used as walling stone. The Teign Valley dolerites are a significant building stone source in this area and to a limited extent elsewhere. They feature in both field and house walls, and were frequently used as footings for cob-walled buildings.

Other intrusive rocks

Hatherleigh Stone was produced from the numerous quarries that once worked the lamprophyric minor intrusions occurring to the south and south west of Hannaborough. The name 'Hatherleigh Stone' derives from the town to the north east where the stone is mainly used. The stone itself is a buff or pale brown, medium-grained rock, which is strong but easily shaped; some blocks can be quite pitted. The main distinguishing feature is the growth of lichen or, more likely, algae on exposed surfaces. This imparts a pink colour, allowing easy identification even at a distance. Hatherleigh Stone is widely used for **QUOINS** and **DRESSINGS** in the churches found around Hatherleigh and for the dressings of the later parts of Okehampton Castle. It has also been used in Winkleigh, South Molton and North Molton both for quoins and walling.

Further to the west, the 'Halwill Freestone' is of local significance in the Holsworthy area. This is another lamprophyric rock, albeit finer-grained, that is generally micaceous and often contains 'blebs' of quartz. It is grey in colour, weathering to a brown-grey, and has a tendency to spall. Halwill Freestone has been used primarily for the building of railway bridges and churches, as well as some houses and farms.

Elvan (or Roborough Stone) is a local name used in Devon and Cornwall for varieties of quartz porphyry. The two names for this stone are often interchangeable, and an alternative name for both is 'Greenstone'. This is a grey, fine-grained rock with a spotted appearance arising from the sporadic presence of larger quartz and feldspar crystals set within the fine-grained matrix.

The stone is soft to quarry, but hardens upon exposure to the elements. It saw use as a building stone, but was also quarried as an aggregate. 'Greenstone' use has been mainly confined to churches and other older higher status buildings, particularly to the west and south of Dartmoor. Some rounded stones used in villages to the south west of Dartmoor have clearly been derived from secondary fluvial sources.

Sandstones and Volcanic Rocks

Exeter Group

Thorverton Sandstone and Knowle Sandstone formations

Thorverton & Knowle sandstones

Sandstones assigned to these two formations are reported to be used for building purposes in and around the villages after which they are named. However, very few buildings that incorporate sandstone that can confidently be assigned to either formation have been encountered during this study. In the few cases when a definite assignation can be made (such as Thorverton Parish Church, image below), the sandstone is found to be brick red and rather soft (akin to the younger 'Dawlish Sandstone'), and is usually associated with lava of the 'Exeter Volcanic Series' (the sandstone, in some cases, forming inclusions within the lava blocks).

'Exeter Volcanic Series' rocks

The Exeter Volcanic 'Series' comprises extrusive and (shallow-level) intrusive volcanic rocks that occur at or near the base of the Permian succession lying to the north and west of Exeter. Typically found as small, isolated outcrops, these generally basaltic rocks are best developed around Silverton, Thorverton and Budlake in the north, and around Ide and Dunchideock further south west. The stones have been widely used for construction purposes across Devon, particularly for higher status buildings, and are an important group of building stones.

Typically, the 'Exeter Volcanic Series' lavas are pink, purple, grey or violet coloured, fine-grained, vesicular rocks (although local variations occur). The building stones are commonly named after their quarries of origin, with the result that 'Rougemont', 'Killerton', 'Posbury', 'Thorverton' and 'Raddon' stone commonly appear in the literature. Some buildings include different varieties of the stone, which are used as decoration or indeed at random. The common feature of these rocks is their constituent mineralogy, including the alteration product iddingsite (a distinctive red mineral), and the presence of vesicles (gas escape cavities) and/or amygdales (vesicles infilled by a mineral phase).

Rougemont Stone is a dark-coloured rock with vesicles, which are variably filled with white **CARBONATE**, zeolites, chlorite and other alteration products. Distinctive, random, quartz-filled vesicles and veins run through the stone and define a 'flow foliation'. This was an important building stone, originally sourced from Rougemont Gardens in Exeter. Pocombe Stone shows similar characteristics to Rougemont Stone, except that it is slightly paler purple in colour and has parallel 'bands' of quartz-filled vesicles and veins. It is seen with some regularity in the village of Ide. Posbury Stone is a 'spotted', dark coloured rock, with small quartz phenocrysts. It is vesicular and/or amygdaloidal in part, with the vesicles being filled with carbonate or 'clay' minerals. Veining is not prominent. This is the most widely used building stone amongst the Exeter Volcanics. The Raddon and Thorverton stones are again dark coloured rocks, with vesicles and amygdales in part (the vesicles again being filled with carbonate or 'clay' minerals). Raddon Stone tends to have a distinctly pinker colouration. Inclusions of red-brown Thorverton sandstone are often present.

These stones are not only the most common building stone encountered in the Thorverton and Raddon areas, but have also been used in Cullompton, Down St Mary, Stockleigh English and the Creedy Valley. Some of the buildings constructed using it, such as The Waldrons in Cullompton, are higher status buildings and, despite its relatively limited geographical spread, it might be considered a key Devon building stone simply because of the many buildings in which it is found. The Killerton Stone, finally, is a dark coloured, lamprophyric rock containing abundant biotite. It was used in the Killerton and Broadclyst areas, and saw extensive use on the National Trust's Killerton Estate (including the nearby Chapel, shown below).

The Exeter Volcanics, generally, were widely used in and around the City of Exeter, in an area extending from Ide in the south west, to Thorverton, the Clyst valley and Whimple in the east. They are also a minor constituent of buildings over a much larger area taking in Pitminster in the Vale of Taunton Deane (Somerset), Sidmouth and South Brent. Specific examples include the city walls of Exeter, Rougemont (Exeter) Castle and many of the Exeter's churches. The stone was quarried from Rougemont itself and from Northernhayes (immediately to the north) in Roman and Medieval times.

Later buildings in the city employed stone from the quarry at Exonia Park (Pocombe Stone), which is easily identified by virtue of its sub-parallel veins of carbonate. The pink, highly vesicular lava used for Crediton church, meanwhile, originated from Posbury Clump. The Bishop of Exeter maintained a quarry at Barley, a location not now easy to pinpoint exactly but one 'remembered' in the names of nearby Barley Lane and Quarry House, from where stone for the interior of the walls of the cathedral was quarried.

Breccias and Sandstones

The Exeter Group principally comprises a series of formations which are dominated by beds of coarse-grained breccia (angular clasts) and conglomerate (rounded clasts). These rocks were locally important as sources of building stone. For the purposes of description, and to reflect the difficulties inherent in pinpointing the formational origins of the breccias when seen in a building, the Exeter Group rocks have been broadly divided into those without pebbles and cobbles of grey limestone (e.g. the Newton St Cyres and Heavitree Breccia formations) and those with these clasts (e.g. the Torbay Breccia Formation).

It is generally believed that the breccias lying stratigraphically beneath the Newton St Cyres and Heavitree formations are too soft to be used for building purposes, although some examples of breccia blocks matching published descriptions of the Bow and the Alphington breccias have been observed (notably in Bow and in the tower of Dunchideock church; see also discussion of the Sampford Peverell Breccio-conglomerate).

Heavitree Breccia Formation

Heavitree Breccia (also known as Wonford Breccia, Exminster Breccia and Whipton Stone)

The Heavitree Breccia consists of angular clasts of a range of rock-types (principally derived from the subjacent formations) set within a matrix of coarse-grained red sandstone. The clasts reach small cobble size and are mainly of low-grade metamorphic lithologies (including red, brown and black fine-grained sandstones, greywackes, slates and hornfelses) with, in many cases, a significant component of fine- and medium-grained igneous rocks (including granite, quartz–feldspar porphyry) and fragments of alkali feldspar (the so-called merchisonite). The clasts are angular and poorly sorted. At the scale of a building stone block, the clasts show very little preferred orientation and bedding is generally absent.

The rock has a variable degree of cementation, and the best quality stone (generally that with a porous sandstone matrix) is well cemented by white calcium carbonate. Individual blocks can be large, but because of the coarse nature of the stone, were evidently hard to dress and sometimes have somewhat rounded margins. A common practice when using this stone is to pack out the voids between the rounded blocks with smaller pieces of another stone (i.e. 'galleting').

Heavitree Breccia is widely used in Exeter and nearby parts of eastern Devon, extending southwards about as far as Dawlish. The image below shows its use in Cathedral Yard, Exeter (in conjunction with Rougemont Stone, which is used for the archway).

Important quarries which produced this stone from the second half of the C14 onwards are found within modern day Exeter and its immediate surroundings. These quarries, such as Heavitree, Wonford, Whipton and Exminster, all lend their names to the stone that was produced at them. The various names are interchangeable, but 'Heavitree Breccia' is the most common.

Sampford Peverell Red Breccio-conglomerate

At Sampford Peverell, Exeter Group breccia was worked for building stone in the old quarries lying close to the A361. It is distinct from the breccias found in buildings elsewhere in Devon. The clasts are angular to rounded, of granule- and pebble-grade (or, in some cases, cobble-sized), and set within a coarse-grained sandstone matrix. Many of the pebbles are oblate, with their long axes tending to lie parallel to (and indeed defining) the bedding; they are sometimes imbricated. The clasts include fragments of dark red, grey and black sandstone and greywacke, white vein quartz and pale grey limestone; vein quartz is especially abundant. The limestone clasts tend to be better rounded than those of the other lithologies. Fragments of igneous origin appear to be entirely absent, which stands in contrast to the Heavitree and Newton St Cyres Breccias used further south. The matrix is rather muddy and differential compaction of the mud fraction serves to emphasise the bedding. Breccias of this type have been used for building in the Uplowman-Halberton-Sampford Peverell-Burlescombe-Ayshford-Bathealton area, and mostly in and around the first three of these villages. The breccia is also much used for the bridges and bank reinforcement along the Grand Western Canal. The Sampford Peverell Breccia may be a correlative of the Cadbury Breccia (lying at the base of the Exeter Group), but it should be noted that the muddy nature of the Cadbury Breccia has precluded its use as a building stone.

Torbay Breccia & Oddicombe Breccia formations

Torbay Breccia (also known as Paignton Breccia, Nethercombe Breccia, Torre Breccia, Oddicombe Breccia, Teignmouth Breccia and Watcombe Breccia)

These principally red breccias, which crop out in the Teignmouth and Torbay areas, contain prominent clasts of medium- and pale-grey Devonian limestone – serving to distinguish them from the other breccias of the Exeter Group. The clast population in general comprises limestone, porphyry, vein quartz, slate, red and black sandstone and greywacke (more or less foliated), grey banded quartzite, schorl and murchisonite.

The clasts are mainly angular, but those of limestone and porphyry may be moderately to well rounded. The bedding, especially in the finer grained horizons, is accentuated by variation in the proportion, average size and/or composition of the clasts. The matrix, meanwhile, is of poorly sorted, fine- to coarse-grained sandstone (with variable amounts of siltstone and mudstone), and is carbonate-cemented; quartz grains predominate, with subordinate feldspar and lithic fragments. The matrix appears red or maroon owing to the presence iron oxide grain coatings. Bands and lenses of pebbly sandstone are variably present.

The Torbay and Oddicombe breccias are widely used for building in their outcrop areas. Nearly all the houses and garden walls of the Maidencombe area of Torquay are constructed of this kind of red breccia, giving the area a very distinctive and aesthetically pleasing appearance.

'Red Rock Sandstone'

A hard, red sandstone distinct from that occurring as bands and lenses within the Permian breccia succession is found at the base of the Torbay Breccia. It is medium-grained, is usually well sorted, has sub-angular to well rounded grains and typically lacks bedding or other sedimentary structures (although, at times, bedding is defined by variations in grain size and degree of cementation). The sandstone is composed of quartz grains cemented by calcite. Partial infilling of the voids between the grains by later silica **CEMENTS** has produced patches within the sandstone which have a 'glassy' appearance (and which sparkle in the sunlight). A small proportion of the blocks of this sandstone encountered during this study are coarser-grained, with grains up to granule-grade.

'Red Rock Sandstone' features to a limited extent in the limestone walls of Brixham and Exmouth (n the case of Brixham, a very large proportion of the walls contain a few blocks of this sandstone). The sandstone is also widely used for the quoins and dressings in medieval and early modern high-status buildings, including many of the churches in the Brixham-Chudleigh-Buckfastleigh-Totnes area (e.g. Torre Abbey, Buckfast Abbey (medieval parts) and Berry Pomeroy Castle). The local school of Norman font carvers favoured the stone, and it was clearly much sought after in those times due to its combined qualities of workability, toughness and resistance to erosion and attractive appearance.

This sandstone is the main building material of the village of Bishopsteignton, perhaps originating from an outcrop on the slopes just to the north of the village (although the particular sandstones are now considered to form part of the Heavitree and Alphington Breccias). 'Red Rock Sandstone' is also common in parts of Teignmouth, Ideford and nearby Luton. The pinnacles of Harberton Parish Church's tower incorporate a distinctive red sandstone which is believed to be the 'Red Rock' Sandstone' (image below).

Porphyry Boulders

Rounded boulders and pebbles of quartzo-feldspathic porphyry have been used for rough walling in and around Dawlish, Teignmouth and Shaldon, and in other nearby villages. These are believed to have been derived from the Exeter Group breccias of the local area, but were likely 'quarried' – or, more accurately, gathered – from river or stream sediments as opposed to being extracted directly from the breccias.

Dawlish Sandstone Formation

Poltimore & Dawlish sandstones

These brick to dark red sandstones shows a wide range of characteristics. They can be fine- or coarse-grained and are well to poorly sorted. The constituent grains are mainly of sub-angular to sub-rounded quartz, feldspar and lithic fragments. Some of sandstones contain a distinctly coarser-grained fraction of well rounded grains with a 'frosted' surface finish, which is believed to indicate aeolian transportation. The well sorted varieties may have sparse carbonate cement, while poorly sorted varieties may contains pebbles and indeed lenses of breccia or conglomerate; still other varieties have a muddy matrix. In general, albeit with a few exceptions, these sandstones are rather soft and individual blocks seen in buildings tend to have rounded outlines and surfaces smoothed by erosion.

'Poltimore Sandstone' is used in a few buildings in Exeter and along the Exe Estuary, but it features most prominently around Poltimore and Broadclyst (the image above shows its use in a bus shelter at Broadclyst). Thin blocks of this sandstone are used to even up the courses of walls constructed largely of Permian breccia in the Sowton and Clyst Honiton area. Considering the extensive and striking exposures of red sandstone at the Dawlish type locality, it is used surprisingly little as a building stone in the town itself, perhaps because of its poorly cemented nature.

TRIASSIC

The sandstones, pebble beds and mudstones of Devon's Triassic succession are mainly 'red-bed' sediments laid down under tropical desert conditions dominated by wide river floodplains and temporary lakes. At the top of the succession, there are greenish grey mudstones and limestones which mark the transition to the marine conditions that largely prevailed during the subsequent Jurassic.

Aylesbeare Mudstone Group

Exmouth Mudstone and Sandstone Formation

Though similar in character to the Permian Dawlish sandstones which crop out on the opposite side of the Exe Estuary, sandstones from this formation are less widely used as a building stone. The sandstones are typically mottled in shades of fawn, red and pale pink, and are mainly medium-grained and well sorted. There are some less well sorted, gritty layers which consist of poorly cemented sub-rounded to sub-angular grains of quartz; these layers are more porous and permeable. A crude bedding fabric is usually present defined by variations in grain size and colour (and is highlighted by variable resistance to weathering), and cross-bedding is visible in some large blocks. This sandstone has been used only locally (presumably due to the availability of other superior building stones close by), being best seen in the Woodbury–Exmouth area.

Sherwood Sandstone Group

Budleigh Salterton Pebble Beds Formation

'Budleigh Buns'

The term 'Budleigh Buns' refers to the well-rounded cobbles and pebbles – mainly of grey, yellow, brown and liver-coloured (meta-)quartzite – derived from the Budleigh Salterton Pebble Beds which were an important local source of building material.

The formation includes a small proportion of clasts, usually less well-rounded, of dark coloured tourmalinite. Pebbles carefully selected on the basis of their size are quite widely seen as a decorative finish to walls.

Erosion and reworking of the Pebble Beds during the Quaternary has led to their constituent clasts being widely distributed downstream of their outcrops. Their use in the coastal towns of East Devon probably reflects their presence in the river gravels and beach shingle of these towns. It is noteworthy that although the outcrop of the source unit continues to the north, buildings that make use of Budleigh Buns have not been encountered to the north of Plymtree. The image below shows a cobble wall constructed of Budleigh Bunds in Budleigh Salterton.

Otter Sandstone Formation

Red sandstone is the most abundant **LITHOLOGY** within the Otter Sandstone Formation and has been used for building in the lower Otter Valley. It is typically a medium-grained sandstone composed of grains of quartz set in sparse calcite cement. Mica is locally present. Bedding is evident in many wallstones, and some blocks show cross-bedding. Rounded edges and corners are a feature of most blocks of this stone.

In the buildings of the Otter Valley, relatively good quality sandstone of the type described above is accompanied by a range of other, softer sandstones composed of quartz grains set within a muddy or marly matrix.

Otter Conglomerate

This is a red, occasionally almost black, conglomeratic lithology, comprising rounded muddy sandstone fragments of up to 3 cm in size set within a medium-grained, calcareous sandstone matrix. Many of the blocks of this stone seen in buildings also include some angular fragments, reaching pebble-size, of harder sandstone, greywacke and hornfels (derived from the Devonian and Carboniferous successions). The conglomerate usually has a pronounced bedding fabric defined mainly by the preferred alignment of the included fragments. Being softer than the matrix in most cases, these fragments weather out giving the rock a curious pock-marked appearance. The Otter Conglomerate is easily distinguished from the Budleigh Salterton Pebble Beds lithologies owing to the fact that the latter is too poorly cemented to be used; as a rule, only the individual pebbles ('Budleigh Buns') are incorporated into buildings.

Otter 'mud-pebble conglomerate' is used for building in the lower Otter Valley as far north as Ottery St Mary and Feniton. This would appear to be the limit of its use.

The image below is of St Mary's Church in Ottery, which uses Otter Conglomerate in its walling.

JURASSIC

Lias Group

Limestones and mudstones of Lower Jurassic age are present only in the extreme east of Devon, cropping out along the coast near Lyme Regis and inland to the north and east of Axminster.

Blue Lias Formation

Blue Lias Limestone

Although Blue Lias Limestone is perhaps best known as a building stone in Somerset, there are small developments in Devon which extend southwards as a discontinuous series of inliers through Blackwater, Bishopswood and Wambrook in the Blackdown Hills, and continue through Axminster and Uplyme to Lyme Regis on the south coast. None of these Devon outcrops are quarried today.

Blue Lias Limestone is a grey or pale yellow-brown, fine-grained, soft, muddy limestone which sometimes contains fossils. Hard, blocky limestones of no more than 15–30cm thick are interbedded with softer, more thinly bedded, argillaceous limestones. The building stones principally come from the blocky limestone beds. When fresh, the rock is dark to light grey, but it weathers fawn or buff. Blue Lias Limestone is not very durable over the long term and most of the locally produced stone shows signs of weathering – the surface layers tend to flake off and as this process proceeds, and the stone is gradually eroded away, leaving the mortar between blocks standing proud.

LOWER CRETACEOUS

Selborne Group

Upper Greensand Formation

The (Albian to Cenomanian) Upper Greensand Formation was deposited in warm, shallow, tropical seas which contained an abundance of life. It is well exposed in eastern Devon, especially along the sea cliffs from Sidmouth to Lyme Regis, inland in the Blackdown Hills, and in the Haldon Hills west of Exeter. The formation reaches 50 m in thickness.

The 'Greensand' owes its name to the slightly greenish colour imparted by the presence of the iron-bearing silicate mineral glauconite. When exposed to the elements, however, it is commonly oxidised to a rusty yellow or brown colour. Fossils – including molluscs, brachiopods, echinoids, ammonites, foraminifera and fish teeth – are common in these rocks.

Calcareous Grit

This is a medium- to fine-grained calcarenite, composed of sub-angular grains of carbonate set within a finer grained calcareous matrix. The rock weathers to a pale grey colour, with the carbonate clasts standing out from the matrix. The 'Calcareous Grit' bears some resemblance to 'Beer Stone' which, when not affected by spalling, may also show carbonate clasts standing proud of the grey weathered surface. The Calcareous Grit was commonly used in buildings in association with Beer Stone, for example, in several churches in the Newton Abbot area, where Beer Stone is used for the dressings and Calcareous Grit blocks for the quoins. Given their close resemblance, the Calcareous Grit could be considered as a substitute for Beer Stone wallstone blocks (see also p. 23).

Salcombe Stone

Salcombe Stone is a fawn, grey-weathering, medium- to coarse-grained calcareous sandstone. It is composed of poorly sorted, sub-rounded to sub-angular clasts of calcite, with subordinate quartz grains, and cemented by porous carbonate. Around Chard, close to the Somerset–Devon border, there is a gradual increase in the proportion of fine-grained carbonate cement, an increase in the proportion of quartz clasts, and consequent loss of the distinctive colour of true Salcombe Stone. It is often still difficult to tell these rock types apart, however, and there is likely to be a substantial overlap in the use of the stone originating from the two areas.

Salcombe Stone is widely used for building around the source quarries at Salcombe and Dunscombe (near Sidmouth) and, most famously, is the main building stone of Exeter Cathedral. The traditional quarries have been reopened from time to time for repairs to the cathedral and other local churches (notably at Salcombe Regis), but there is no on-going production. Due to the local use of the stone in high status buildings in Devon, Salcombe Stone is considered to be a key building stone.

Bindon Sandstone Member

Malmstone or Whitestaunton Stone

This is a rather porous, light grey, medium-grained, calcareous sandstone of late Albian age. It consists of poorly sorted grains of translucent quartz and chalky calcite sparsely cemented by powdery calcite. The proportions of quartz and calcite grains vary, and varieties in which one greatly predominates over the other are common. Green glauconite and black iron oxides derived from it are common components of this stone. Bedding is evident in many blocks, usually poorly defined by variations in grain size, clast composition, degree of cementation and colour. The presence of the fine-grained carbonate cement encourages the growth of a characteristic crimson lichen or alga, which can help to distinguish this stone from those originating from the Permian and Triassic successions (especially on north-facing walls).

The Malmstone/Whitestaunton stone was formerly quarried around Whitestaunton, Chard, Tytherleigh and Chaffcombe on the Devon–Somerset border, where it widely features in buildings. Its presence is restricted to areas where the Upper Greensand is overlain by the Chalk Group. The stone is of good quality and is easily dressed, and was used for quoins and dressings throughout the Blackdown Hills and beyond.

Glauconitic Sandstones:

There are two forms of Glauconitic Sandstone used for building purposes, one a medium-grained, strongly green variety, used extensively in eastern Devon, and the other a grey, coarse-grained variety, having a more limited use as a walling stone between the Axe Valley and Uplyme.

'Green Glauconitic Sandstone'

This is a green-grey to pale brown coloured, medium-grained sandstone composed mainly of angular quartz grains with disseminated, rounded, green glauconite grains (often weathering black). The framework is cemented by chalcedonic silica, but may be highly porous with many voids. The combination of angular quartz grains and irregular cement distribution gives the rock a very rough/ragged appearance. Some blocks are rich in acicular sponge spicules, and some contain distinctive, scattered, orange-stained millet seed quartz grains. Where the glauconite is disseminated and the siliceous cement well developed, the surface of the rock tends to have a 'compact', glassy appearance and the individual clastic grains are barely discernible. Some surfaces are characterised by a pimply appearance.

Wallstone blocks are generally small (about the same size as a standard brick), irregular, and often lack obvious bedding. However, large slabs of this sandstone (usually with a crude, but well-defined bedding fabric) have been used for the dressings – and especially the quoins – of medieval churches, and this rock type was clearly prized. Lichen and moss tend to thrive on 'Green Glauconitic Sandstone' and, although this obscures the nature of the rock beneath, this is in fact one of its secondary characteristics.

'Green Glauconitic Sandstone' has a well defined distribution on the western slopes of the Blackdown Hills, extending from Blackborough as far south as Whimple and Combe Raleigh. It is also found in the lower Sid Valley. It is much less used on the tops of the Blackdowns. This distribution closely matches the localities where siliceous 'Devon Batts' (whetstones) were formerly mined. The distribution further south would suggest that the building stone was widely transported as a by-product of whetstone mining. The 'Green Glauconitic Sandstone' is another key vernacular building stone in the county. The image below shows the use of Green Glauconite Sandstone (walling) and Beer Stone (**TRACERY**) in the Church of St Paul, Honiton.

'Grey Glauconitic Sandstone'

This very coarse- to medium-grained, grey or yellowish sandstone consists of sub-rounded quartz and subordinate calcite grains, with scattered greenish glauconite and/or black iron oxide grains. Hard and well cemented, friable, and dark grey and 'compact' varieties all occur. In the Sidmouth area, the sandstone is very soft and tends to form rounded cobbles and boulders. In contrast, in the Combpyne–Rousdon–Lyme Regis area, the sandstone tends to be coarse-grained and well cemented. In general, however, the rubbly and coarse-grained nature of 'Grey Glauconitic Sandstone' makes it less suitable as a building stone.

UPPER CRETACEOUS

Chalk Group

The (Cenomanian to Maastrichtian) Chalk Group is largely composed of chalk, with layers and nodules of **FLINT**. In Devon, this unit is around 100 m thick, and it forms a rounded, elevated plateau inland and spectacular, high cliffs at the coast. The chalks crop out in the upper parts of the sea cliffs and also inland within an area lying to the east of Sidmouth, notably around Branscombe and between the mouth of the River Axe and Lyme Regis; the best exposures are provided by the cliffs at Beer. Away from the coast, the chalks are most extensively developed near Membury.

The chalks themselves comprise the remains of coccoliths and other microscopic algae. Larger fossils are abundant and include bivalves (molluscs) and echinoids (sea urchins).

Holywell Nodular Chalk Formation

Beer Stone

The name 'Beer Stone' applies to a development of hard, homogeneous, white or pale cream coloured chalk occurring within the Holywell Nodular Chalk Formation at the base of the local Chalk Group succession. It is particularly suitable for use as '**FREESTONE**'. When freshly quarried the stone is soft and easily sawn and shaped, but it hardens on exposure to the air. The beds are around 5 m in thickness and the stone has been worked both in surface quarries and underground. When used externally, it tends to suffer from 'flaking', but because of its general characteristics, it was much sought after and used for decorative work.

The qualities of Beer stone have been known since at least Roman times. The main workings are at the Beer Quarry Caves between Beer and Branscombe. There is evidence of both Roman and Norman activity within the more recent early C20 excavations. The location of the quarries, near to the coast, enabled the stone to be shipped much further afield, and Beer Stone was used in many cathedrals and parish churches, including Westminster Abbey and the adjoining St Stephen's Church, Rochester Cathedral and for window carvings at Windsor Castle. More locally, it has been used in Exeter Cathedral and Guildhall, and in many of Devon's parish churches. In the local parish, it has also been used for wallstone in houses and cottages. Given its widespread use in some of the most important buildings in Devon and southern England generally, Beer Stone can be regarded as one of the county's primary building stone resources.

Until recently, a small amount of Beer Stone was extracted from a surface working located along Quarry Lane (after removal of the overlying Chalk by modern excavators). In addition, some material was worked underground in the Caves there.

The presence of bat colonies and recognition of the geological importance of this area have complicated commercial extraction of Beer Stone and it is not actively worked.

Sutton Stone, originating from Sutton Quarry near Offwell, is similar to Beer Stone (Woodward and Ussher, 1911) and was used for local buildings in the Widworthy–Offwell area of eastern Devon.

Flint

Flint nodules (composed of dark grey or black cryptocrystalline silica) have seen use as a building material in Devon, but generally for decorative rather than structural purposes. The flints may have been obtained directly from the Chalk Group or in 'reworked' form from superficial deposits of Tertiary or Quaternary age.

Glossary

Carbonate: A general term used for sedimentary rocks consisting of 50 per cent or more of either calcite (calcium carbonate) or dolomite (magnesium carbonate).

Cement: The materials which bind the grains and/or fossil components together to form a rock.

Chalk: A very fine-grained white limestone composed principally of microscopic skeletal remnants known as coccoliths.

Conglomerate: A sedimentary rock made up of rounded pebbles (>2mm), cobbles and boulders of rock in a finer-grained matrix.

Dressings: To say a building is constructed of brick with stone dressings means that worked stone frames the corners and openings of the structure.

Flaggy: A finely laminated, sedimentary rock that splits into thin sheets when exposed to weathering.

Flint (or Chert): Hard, resistant beds or nodules composed of cryptocrystalline silica. The use of the term flint is restricted to nodules and beds that occur only in Chalk (Upper Cretaceous) rocks.

Fossiliferous: Bearing or containing fossils.

Freestone: Term used by masons to describe a rock that can be cut and shaped in any direction without splitting or failing.

Interbedded: Occurs when beds (layers or rock) of a particular lithology lie between or alternate with beds of a different lithology. For example, sedimentary rocks may be interbedded if there were sea level variations in their sedimentary depositional environment.

Limestone: A sedimentary rock consisting mainly of calcium carbonate ($CaCO_3$) grains such as ooids, shell and coral fragments and lime mud. Often highly fossiliferous.

Lithology: The description of a rock based on its mineralogical composition and grain-size e.g. sandstone, limestone, mudstone etc.

Mudstone: A fine-grained sedimentary rock composed of a mixture of clay and silt-sized particles.

Outcrop: Area where a rock unit is exposed at the ground surface.

Quartz: A crystalline form of silica - silicon dioxide, SiO_2.

Quoin: The external angle of a building. The dressed alternate header and stretcher stones at the corners of buildings.

Rubble: Rough, undressed or roughly dressed building stones typically laid uncoursed (random rubble) or brought to courses at intervals. In squared rubble, the stones are dressed roughly square, and typically laid in courses (coursed squared rubble).

Sandstone: A sedimentary rock composed of sand-sized grains (i.e. generally visible to the eye, but less than 2 mm in size).

Siliceous: A rock which has a significant silica content (non-granular) usually in the form of an intergranular cement e.g. siliceous limestone, siliceous sandstone.

Siltstone: A sedimentary rock composed of silt-sized grains (i.e. only just visible to the eye).

Tracery: An architectural term used primarily to describe the stonework elements that support the glass in a Gothic window. The term probably derives from the 'tracing floors' on which the complex patterns of late Gothic windows were laid out.

Tufa: A thin, surficial, soft (when fresh), spongy, incrustation around the mouth of springs, seams and streams carrying calcium carbonate in solution. (Often enveloping plant material).

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