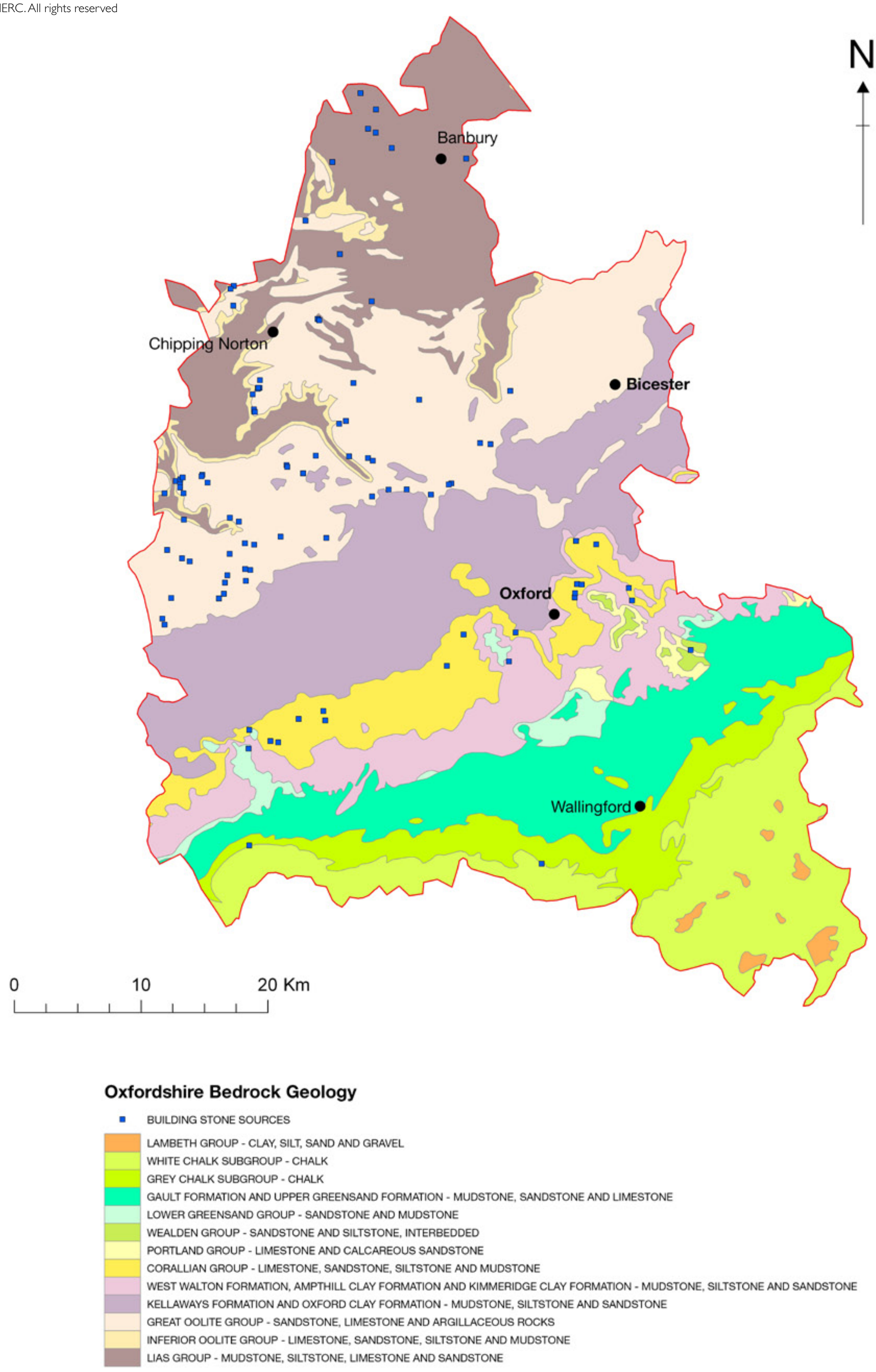
STRATEGIC STONE STUDY

A Building Stone Atlas of OXFORDSHIRE

ENGLISH HERITAGE

Oxfordshire Bedrock Geology



Click on this link to visit Oxfordshire's geology and their contribution to known building stones, stone structures and building stone quarries (Opens in new window http://maps.bgs.ac.uk/buildingstone?County=Oxfordshire)

Main stratigraphical subdivisions and representative rock units in Britain [THIS IS A DRAFT ONLY]

CHRONOSTRATIGRAPHICAL (TIME/ROCK) UNITS			AGE (Ma) *	EXAMPLES OF LITHOSTRATIGRAPHICAL (ROCK) UNITS INCLUDED IN THIS GUIDE**
ERATHEM	SYSTEM	SERIES		
CAINOZOIC (CENOZOIC)	QUATERNARY	HOLOCENE	0.01	*Alluvium, river terrace deposits, peat, coastal and estuarine deposits, etc.*
		PLEISTOCENE	1.80	*River terrace deposits; glacial till, sand and gravel, laminated clay; colluvium, etc.*
	NEOGENE[T] tab 2-3		23	Norwich Crag Fm; Red Crag Fm
	PALAEOGENE[T] tab 2-3		65	Barton Gp; Brackelsham Gp; Bagshot Formation; Thames Gp (including London Clay); Lambeth Gp
MESOZOIC	CRETACEOUS tab 4-9	UPPER	99	Chalk Gp
		LOWER	142	Upper Greensand Fm; Gault Fm; Lower Greensand Gp; Wealden Gp; Speeton Clay Fm; Claxby Ironstone Fm
	JURASSIC tab 10-18	UPPER	159	Portland Gp; Purbeck Gp; Ancholme Gp(including Kimmeridge Clay Fm and Oxford Clay); Corallian Gp
		MIDDLE	180	Great Oolite Gp; Inferior Oolite Gp; Ravenscar Gp
		LOWER	206	Lias Gp
	TRIASSIC tab 19-25		248	Penarth Gp; Mercia Mudstone Gp; Sherwood Sandstone Gp
PALAEOZOIC	PERMIAN tab 26-30		290	Roxby Fm; Brotherton Fm; Edlington Fm; Cadeby Fm; Basal Permian Sands; Collyhurst Sandstone Fm; Ashow Fm; Kenilworth Fm; Bromsgrove Sandstone Fm
	CARBONIFEROUS tab 31-43		354	Warwickshire Gp; Halesowen Fm; Etruria Fm; Coal Measures Gp; Millstone Grit Gp; Strathclyde Gp; Clifton Down Gp; Worston Shale Gp; Alston Gp
	DEVONIAN tab 44-50		417	Upper Old Red Sandstone; Lower Old Red Sandstone; Stratheden Gp; Strathmore Gp; Raglan Mudstone Formation
	SILURIAN tab 46-47		443	Much Wenlock Limestone; Elton Fm; Coalbrookdale Fm Stockdale Group; Downton Group
	ORDOVICIAN tab 46; 49-50		495	Skiddaw Gp; Windermere Supergroup; Dent Group;
	CAMBRIAN tab 48-50		545	Stockingford Shale Gp; Hartshill Sandstone; Wrekin Quartzite; Malvern Quartzite
'PRE-CAMBRIAN' OR PROTEROZOIC	tab 51-52		>545	Charnian Supergroup; Longmyndian Supergroup; Dalradian Supergroup; Moine Supergroup

*Ma = MILLIONS OF YEARS BEFORE PRESENT [APPROXIMATE RADIOMETRIC AGES; GRADSTEIN AND OGG, (1996)];
** FOR FURTHER SOURCES OF INFORMATION ON QUATERNARY DEPOSITS (ITALICS) - SEE SECTION 4
[T] NEOGENE AND PALAEOGENE, TOGETHER, WERE FORMERLY TERMED 'TERTIARY'
Gp = GROUP; Fm = FORMATION; tab = refer to Tables in this Guide

Introduction

The oldest rocks in Oxfordshire crop out in the north of the county and are of Lower Jurassic age, around 200 million years old. Younger Jurassic and Cretaceous formations progressively crop out towards the south. The harder **LIMESTONE** and **CHALK LITHOLOGIES** form **ESCARPMENTS,** whilst clay underlies the intervening vales. The character of Oxfordshire's stone buildings is very much determined by the nature of the local stone, which leads to a fascinating variation of styles across the county. With the exception of the Jurassic **OOIDAL FREESTONE** quarried around Taynton, few building stones were of sufficient quality to be used much beyond their immediate source area. Now only a handful of building stone quarries are still active in the county, supplying Marlstone and the Chipping Norton Limestone. Unfortunately the other building stones described in the following pages are no longer available from working local quarries.

The following summary of the principal local building stones is based largely on Arkell's work "Oxford Stone" and "The Geology of Oxford" and Powell's recent "Geology of Oxfordshire". The oldest stones are described first, progressing towards the **STRATIGRAPHICALLY** youngest to the south.

LOWER JURASSIC
Lias Group
Marlstone Rock Formation

Marlstone, also known as Hornton Stone or Banbury **IRONSTONE** is an iron-rich limestone up to 10 metres thick, quarried from the Middle Lias (Lower Jurassic) of north Oxfordshire. It weathers to a distinctive golden orange/brown colour but can appear bluish green when unweathered. It contains abundant shelly fossils, usually clusters of brachiopods. Both freestone and a rougher, more rubbly stone were quarried, so that Marlstone could be used for both walls and **DRESSINGS** in both small and large buildings. However it is susceptible to weathering and **SPALLING**, so that it has sometimes been later replaced with a more durable ooidal limestone.

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The distinctive warm-coloured Marlstone characterises the cottages in many villages such as Great Tew, Deddington, Adderbury, Bloxham, Wroxton (image above), Hook Norton and Hornton, as well as churches such as St. Mary's in Adderbury and stately houses such as Broughton Castle and Chastleton House (image below). In Oxford its deep colour led to use in ornamental work on buildings such as the University Museum (1859) and the Christ Church Meadow Buildings (1862).


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MIDDLE JURASSIC

Great Oolite Group

Chipping Norton Limestone Formation

Chipping Norton Limestone

This is a buff to white, medium to coarse-grained ooidal limestone (some 2 to 5 metres thick). It lies stratigraphically below the Taynton Limestone but is similar in appearance, though quite variable and sometimes has a flaggy character with occasional bands full of broken shells. Quarried from around Chipping Norton and Charlbury, it was used as a durable freestone in the buildings of these towns and other local villages. The more flaggy lithologies provided roofing for Taynton church; the Castle Barn Quarry still produces roof slates from this formation. The Rollright Stones, a 4000-year-old stone circle, are thought to be constructed from a hard **SILICEOUS** variety of the Chipping Norton Limestone.

Taynton Limestone Formation

Taynton Stone

This is a buff to white, coarse-grained ooidal limestone (5 to 7 metres thick), typically **CROSS-BEDDED** and with abundant shell fragments. It weathers to a light- or golden-brown colour, sometimes with a striped appearance due to differential erosion of beds of varied grain-size or cementation. Well **CEMENTED,** strong and durable, it was quarried for many hundreds of years from some five quarries around Burford, the best quality coming from locations covered by some 5 metres of overlying Hampen Marly beds (Hampen Formation). Seams were thus often followed some distance underground from the quarry face. From the Taynton Quarry itself, blocks up to two metres in height could be obtained, but similar stone was quarried nearby at Swinbrook and Milton in Oxfordshire, and at Barrington, Windrush and Sherborne across the border in Gloucestershire. Stone from the Milton quarries has proved less durable over the years.

Both freestone and **RUBBLE** blocks were extracted and used not only locally to build the stone houses and churches in towns such as Burford, but also for many Oxford buildings (e.g the C13 Merton College Mob Quadrangle, the Divinity Schools - image below, the C 18 Oriel College library, and the C19 New College West Block). Buildings across Oxfordshire used the freestone in **QUOINS** and dressings together with local walling stone. It was shipped further down the Thames for use at Windsor Castle and St Paul's Cathedral, but the stone used at St Paul's has since decayed and been replaced with Portland Stone.

Charlbury Formation

Stonesfield Slate

The Stonesfield Slate is a flaggy grey **MICACEOUS** and sandy limestone, found as **CONCRETIONARY** masses within the Charlbury Formation in a thin sheet of very limited extent around the village of Stonesfield. It can be split into thin slates, which were widely used till the mid-C18 for the roofs of Cotswold cottages and Oxford colleges (e.g Merton College, Wadham College, St. Anne's College library). Thin beds of the stone (up to 2m thick) were mined from underground layers accessed from narrow hillside **ADITS** and shafts. By exposing the moist, freshly-dug slabs to the natural action of winter frosts, they became easy to split.

The stone slates are greyish cream in colour and not as thin or smooth as the true slates of metamorphic origin from the quarries of Wales and the Lake District. The smallest slates were used in the upper parts of a roof, grading into larger and heavier slabs towards the eaves (see top right image). The local slate industry lasted from the late C16 to the early C20 and the original occurrence has now been totally worked out.

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White Limestone Formation

White Limestone

This is a creamy or whitish, fine-grained, thinly-bedded limestone, from near the top of the Great **OOLITE** Group of the Middle Jurassic. The **BIOTURBATED** limestone contains a scattering of ooids and pellets, and fragments of bivalve and brachiopod shells. It is used as a flaggy, rubbly walling stone in domestic buildings and churches along the south flank of the Cotswolds, in a belt from Minster Lovell to Ardley.

Bladon Member

Bladon Stone

Quarries at Bladon near Hanborough have produced a creamy or whitish, cross-bedded, **CALCITE**-cemented shelly oolite some 4 metres thick, from near the top of the Great Oolite. It was used in building the C14 Merton College Library in Oxford, and extensively in C19 and C20 Oxford buildings for both coarsed rubble walling and dressings at Somerville (1933), Rhodes House (1929),

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the New Bodleian - above image shows walls of squared, hammer dressed Bladon stone (1937-9) and the Radcliffe Science Libraries, also for the University Geology and Botany Departments (1937-9):

Forest Marble Formation

Forest Marble

The term Forest Marble was first applied by William Smith to a grey, coarse-grained, cross-bedded ooidal limestone, crowded with blue-black fragments of oyster shells, from the Upper Bathonian at the top of the Great Oolite 'Series'. The stone could be polished for decorative use and was used for internal ornamentation as well as external use. The portico columns of Canterbury Quad in St. John's College, Oxford were cut in 1636 from Forest Marble limestone. The stone was quarried from the Wychwood Forest area, from around Filkins and from the East End quarry at North Leigh. The best stone came from the Longround and Horsebottom quarries to the northeast of Filkins where all of the older cottages were built of Forest Marble. A more **FLAGGY FACIES** was used for roofing, steps, stone paving and as upright slabs for fencing (top image).

In the 1920s and 1930s Sir Stafford Cripps provided locally quarried Forest Marble for building council homes and a new Village Centre in Filkins and for the Morris Memorial Cottages in Kelmscott.

UPPER JURASSIC
Corallian Group

Wheatley Limestone Member

Wheatley Limestone

This is a pale grey, well-cemented, **BIOCLASTIC** limestone, up to 15m thick. It is equivalent in age and transitional to the Coral Rag, and represents a shelf slope facies of broken shells, coral debris and sparse ooids. It is more versatile than the Coral Rag as a building stone, and was quarried from the Wheatley (bottom left image shows typical rough blocks run to course in Wheatley) and Oxford areas from the end of the C13. The rubbly-weathering stone was used for the walls of New College First Quad (ca. 1380) in Oxford, and in villages to the south and east of Oxford. Much was sent to Windsor castle, but after the C14 use of the Headington stones became more prevalent.

Headington Hardstone

This is a massive, well cemented variety of the Wheatley Limestone from the Headington quarries, east of Oxford. It is whitish-yellow in colour, with sparse bioclastic material and ooids, and weathers with a typically pock-marked surface due to the variable erosion of softer mud-filled burrows that cross-cut the fabric. It could be cut easily, but hardened on exposure to a durable building stone, which has survived in place for up to five or six centuries.

Large blocks were widely used in the plinths of Oxford buildings such as the Radcliffe Camera (1737) and the Examination Schools on the High Street. It was used for the New College bell tower (1396-7) with **QUOINS** and dressings of Taynton Stone, and later (1841) for the gate pillars of Oxford County Hall. Replacement of weathered blocks in the Radcliffe Camera has used Portland (Fancy Roach) Stone.

Headington Freestone

This is another variety of the Wheatley Limestone from the Headington quarries, providing a creamy-white or buff-coloured **ASHLARED** freestone found in many Oxford buildings. Although widely used from the C15 onwards, the poorer quality material quarried from the early C18 onwards weathered badly within a couple of centuries. The stone develops a hard, blackish crust, which blisters and exfoliates so that many buildings have since required re-facing with more durable freestones such as Clipsham Stone (Lincolnshire). In Oxford it still survives in the lower storey of the Radcliffe Camera, (below image) built 1737, in the upper walls of Oriel College Hall, and in Trinity College Chapel (1691-3).

Coral Rag Formation

Coral Rag

The Coral Rag (a lateral equivalent of the Wheatley limestone) is a rubbly grey shelly limestone, (up to 10 metres thick), from near the top of the Upper Jurassic Corallian Group. It contains large lumps of corals, both branching and massive. The branching corals may weather out to give tubular cavities. It is relatively hard and resistant to weathering but the poorly-bedded rubbly character means that it is difficult to shape into regular building blocks and could not be used for dressings.

Quarried from the hills around Oxford, it was widely used in the oldest Oxford buildings such as the Late Saxon tower of St Michael-at-the-Northgate (top left image), St Georges Tower at Oxford Castle and for the early C13 city walls. A similar rubbly coral-rich stone from the Faringdon area was used for the walls of the C13 Great Barn at Coxwell, and for many of the older Faringdon buildings.

UPPER JURASSIC

Portland Formation

Portland Limestone

This creamy-white, non-ooidal, sandy and gritty bioclastic limestone from the upper Portland Formation and is locally rich in shell fragments. Large Portlandian ammonites may be seen incorporated in some cottage walls, as seen in the bottom image. It was once quarried as a freestone from a thin bed (up to 2 metres thick), in the area of east Oxfordshire around Great and Little Milton, and Great and Little Haseley. The largest quarry was on the SE bank of Haseley Brook at Upper Standhill. Roughly cut, irregularly-sized blocks were used in local cottages and for the walls of Great Milton church.

UPPER CRETACEOUS

Chalk Group

Chalk Stone

A relatively durable creamy-white chalk was obtained from a restricted area of southwest Oxfordshire. It was easy to cut, and could be shaped into uniform rectangular blocks, up to 50 cm across, for use in regularly coursed walls. Quoins and dressings were normally of a harder limestone or brick, and extra support was provided around windows and doors using wooden beams, brickwork or other stone. Chalk is porous (its porosity can be around 30%) and it was essential to have "good shoes and a hat" to prevent the chalk absorbing water and "spalling". This meant that cottages needed a foundation plinth of brick or sarsen and an overhanging roof (typically thatch) to keep the chalk dry. Chalk stone buildings are seen in the South Oxfordshire villages around Ashbury, Compton Beauchamp, Uffington and Woolstone.

The substantial C17 hunting lodge of Ashdown House (bottom image) was built of fine white chalk stone with quoins and dressings of stronger limestone. The chalk is thought to have been quarried from a hard band such as the Melbourn Rock (3m thick) at the top of the Lower Chalk. In recent years a quarry at Compton Beauchamp was temporarily re-opened to provide stone for repairs at Ashdown House. A similar stone is seen in a few buildings around Watlington and Shirburn, at the foot of the Chilterns in the southeast of the county.

Chalk Clunch

A less durable creamy-grey coloured chalk is seen in buildings along the base of the chalk escarpment from Blewbury through Wallingford, Benson, Warborough and Watlington. This is a softer, **FRIABLE** chalk, which is not easily shaped into regular blocks. It has low strength and weathers poorly, tending to absorb water and spall as a result of winter freezing. Such chalk was used for the regularly-coursed walls of the 400-year-old Smalls House in Mackney, but it has deteriorated over the years. More often it is seen in roughly-coursed boundary walls (see top right image of Chalk **CLUNCH,** protective tile capping and a flint base) or rubbly infill panels, again resting on a base of less porous material (brick, sarsen or flint) and with a protective coping of brick or tile. One source of such chalk was the Chalk Pit at Blewbury, which provided a poor quality chalk building stone from the Melbourn Rock Member. Other similar material may come from the underlying Upper Greensand. Totternhoe Stone from Bedfordshire has often been used as a replacement.

Flint

FLINT is a very hard vitreous stone composed of **SILICA** material, and occurs as irregular nodules, rarely more than a few tens of centimetres in size, within the Upper and Middle Chalk. The newly-excavated nodules have a black core and an outer coating of porous whiter "cortex" which may become yellow-stained from prolonged contact with clays or soils. Flint splits along 'conchoidal' fractures. It is however highly resistant to weathering and can thus be used in walls as a protective outer layer.

Flints can be used in their original nodular form, to give a wall of rubbly appearance, or can be split or "knapped" to give a glassy surface, which is then arranged to face outwards. In skilful hands the flints can be knapped into rectangular blocks which can be laid in courses like bricks. However the shiny impervious surfaces of fully knapped flints do not bond as well with mortar as those flints which still retain their porous cortex. Stone of pure silica or brick courses were often incorporated in a flint wall to give it extra strength. The image bottom right shows a detail of knapped flints used in St Mary's church in Wallingford.

Locally gathered field flints, embedded in mortar, were used to build the rough walls of Saxon and Norman churches (e.g St. Leonards in Wallingford), although their small size precluded use as quoins or as window or door mouldings, for which another material, usually brick or limestone was generally used. By the C13 and C14 the flints were being laid in horizontal courses and were often knapped. In later church building, the flints were more carefully selected and were often knapped more precisely to give squared blocks which could be laid in regular courses, (e.g St. Mary's church in Wallingford) or employed together with squared limestone blocks to give decorative chequer-work patterns. Limestone continued to be used for carved window dressings and door mouldings, for corner stones and buttresses. This use of flint with limestone characterises the majority of church buildings in the Chalk Downs. Weathered flints are common in the soil profiles throughout the chalk districts. Supplies of freshly quarried flint can be obtained from the Hindhay quarries at Fifield near Maidenhead.

TERTIARY

Paleocene

Sarsen Stone

Sarsen stone occurs as large **SANDSTONE** blocks up to several metres in length, which are found as isolated boulders resting on the Chalk bedrock in valleys of the Marlborough Downs in southern Oxfordshire. The bottom left image shows the Shieling. Garden wall in Ashbury of rough sarsen, overlain by chalk block with tile capping, the bottom image shows rough sarsen detailing.

These are the durable scattered remnants of a sandstone, equivalent to the friable Paleocene sands found in the London Basin. Huge sarsen stones were used in their natural unshaped state 5,000 years ago, by the Neolithic builders of the Waylands Smithy Long Barrow and the Avebury Stone Circle. The stone is a hard, silica-cemented quartz sandstone, which in these structures has resisted weathering for thousands of years. However, being so hard, it was not easy to cut and shape. Thus sarsens were initially used in buildings in their original unhewn condition. Small unshaped stones are seen in rough-coursed walls around Ashbury and Uffington, with dressings made of brick, or as the foundation plinths of Chalk or Clunch buildings. They are also widespread as marker stones along roadside verges. In later years, heating the stone using open fires was used to break up the stone into blocks, suitable for walls and corner stones, although not for intricate carved stonework around windows. Working the stone into regular blocks became easier in the mid C19 with the introduction of machinery.

Glossary

Adit: A horizontal passage into a mine.

Ashlar: Stone masonry comprising blocks with carefully worked beds and joints, finely jointed (generally under 6mm) and set in horizontal courses. Stones within each course are of the same height, though successive courses may be of different heights. 'Ashlar' is often wrongly used as a synonym for facing stone.

Bedding plane: In geology, any of the division planes separating the strata or beds in sedimentary rock .

Bioclastic: A limestone composed of fragments of calcareous organisms.

Bioturbated: The mixing of sediment or soil by living organisms

Calcareous: A rock which contains significant (10-50%) calcium carbonate principally in the form of a cement or matrix.

Calcite: The commonest and most stable naturally occurring calcium carbonate mineral. Calcite is the primary constituent in coccoliths and in the shells and skeletons of marine organisms such as foraminifera and molluscs, and therefore of many sedimentary limestones as well as metamorphic marbles and calcareous sandstones.

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

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

Clunch: Collective term for the compact, fairly hard varieties of chalk; greyish white, grey or slightly greenish, and used for building in some eastern counties of England.

Concretionary: A rounded mass of compact layers within a sediment, constructed round a fossil.

Cross-bedding: A feature principally of sandstones formed by the movement of sand grains in currents to produce layering oblique to the margins of the beds.

Dressings: This term is used to describe stone used in such positions, usually in conjunction with walls of another material: to say a building is constructed of brick with stone dressings means that worked stone frames the corners and openings

Escarpment: A steep slope or cliff often formed by faulting or erosion

Facies: A term decribing the principal characteristics of a sedimentary rock that help describe its mode of genesis e.g. dune sandstone facies, marine mudstone facies.

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 occurr only in Chalk (Upper Cretaceous) rocks.

Freestone: Stonemason's term for any fine-grained, uniform, sedimentary rock that can be easily worked, without splitting or cracking, in any direction.

Friable: Term used to desribe the weak or crumbly nature of a rock.

Ironstone: Sedimentary rock which is composed of more than 50% iron-bearing minerals

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

Lithology: A basic description of the material features of a rock, generally as seen with the naked eye, but also including microscopic features. Commonly occurring sedimentary lithologies are sandstone, siltstone, mudstone and limestone; commonly occurring igneous lithologies are granite, diorite, dolerite and basalt.

Micaceous: A rock which contains a high proportion of the platey micaceous minerals muscovite and/ or biotite.

Ooid: A spheroidal grain of calcium carbonate formed by precipitation (by algae) of calcium carbonate in concentric layers.

Oolite: A limestone composed principally (>50%) ooids.

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).

Sedimentary Rock: A rock that is commonly formed by the binding together (lithification) of sediment particles (e.g. sandstone, siltstone, mudstone, limestone).

Silica: The resistant mineral quartz (silicon dioxide) SiO2 an essential framework constituent of many sandstones and igneous rocks, but which also occurs as a natural cement in both sandstones and limestones.

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.

Spalling: Deterioration in the form of detaching flakes, scales or lens-shaped fragments from a generally sound surface.

Stratigraphy: Branch of geoscience dealing with stratified rocks (generally of sedimentary origin) in terms of time and space, and their organisation into distinctive, generally mappable units. See page 2 for a Stratigraphic column.

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

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