The Geology and Landscape of the South Dorset Ridgeway.

The South Dorset Ridgeway is part of the Dorset A.O.N.B and is an area extending 17 km east to west from Poxwell to West Bexington and 7 km north to south from the southern outskirts of Dorchester to the scarp and vale landscape of the Weymouth lowlands. Within this area there are several local geological sites (L.G.S.) which have been designated as sites of geological interest (formerly Regionally Important Geological Sites or RIGS). It is hoped that those interested in the many aspects of the area will find this study of the geology of use to better understand the nature of the landscape, the ecology and the human history. The sites that fall within the study area are as follows:

Site	**Location GR and or postcode.**
Bincombe Hill Quarry	SY689845, DT3 5PU
Corton	SY636854, DT3 4EP
Kingston Maurward Quarry	SY718917, DT2 8PU
Lime Kiln Crags (Abbotsbury)	SY589858, DT3 4LD
North Barn Farm	SY567916, DT2 9EF
Portesham Rocket Quarry	SY610859, DT3 4ES
Poxwell	SY743835, DT2 8ND
Red Lane Abbotsbury	SY575855, DT3 4JS

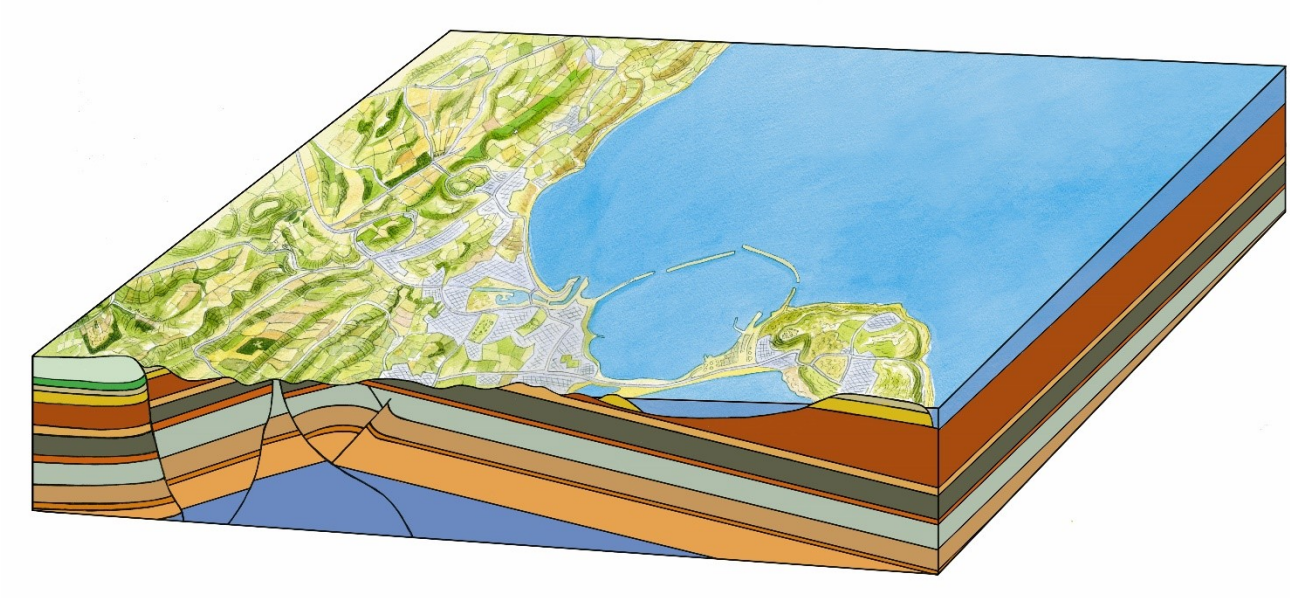
The sites are located across the area from the northern edge of the Weymouth Anticline (Red Lane, Portesham and Bincombe) to the Chalk Valley and Downland in the north (Kingston Maurward and North Barn Farm). Another very interesting area in the east is around Poxwell.

The rocks in the area are all sedimentary in origin and range from late Jurassic rocks at Abbotsbury (Corallian to Kimmeridge Clay passage beds), Portesham and Poxwell, (Kimmeridge Clay and Portland Beds) across the Jurassic Cretaceous boundary with the Purbeck Beds and then the later rocks of the middle and late Cretaceous (Upper Greensand and Chalk) seen at Bincombe Hill Quarry, Lime Kiln Crags, North Barn Farm and Kingston Maurward). Even younger rocks (Palaeogene sands and gravels) are seen around the Hardy Monument giving rise to acid heathland. There are many other sites of geological interest especially around Upwey. One of these is the Upwey cutting along the side of the A354 which the DIGS group looks after to keep the geology exposed. Here the succession is from the top of the Portland Limestone through the whole of the Purbeck Beds to the Wealden although the Wealden is not visible. There are also some disused quarries which still display interesting geology.

Scarp and Vale landscape.

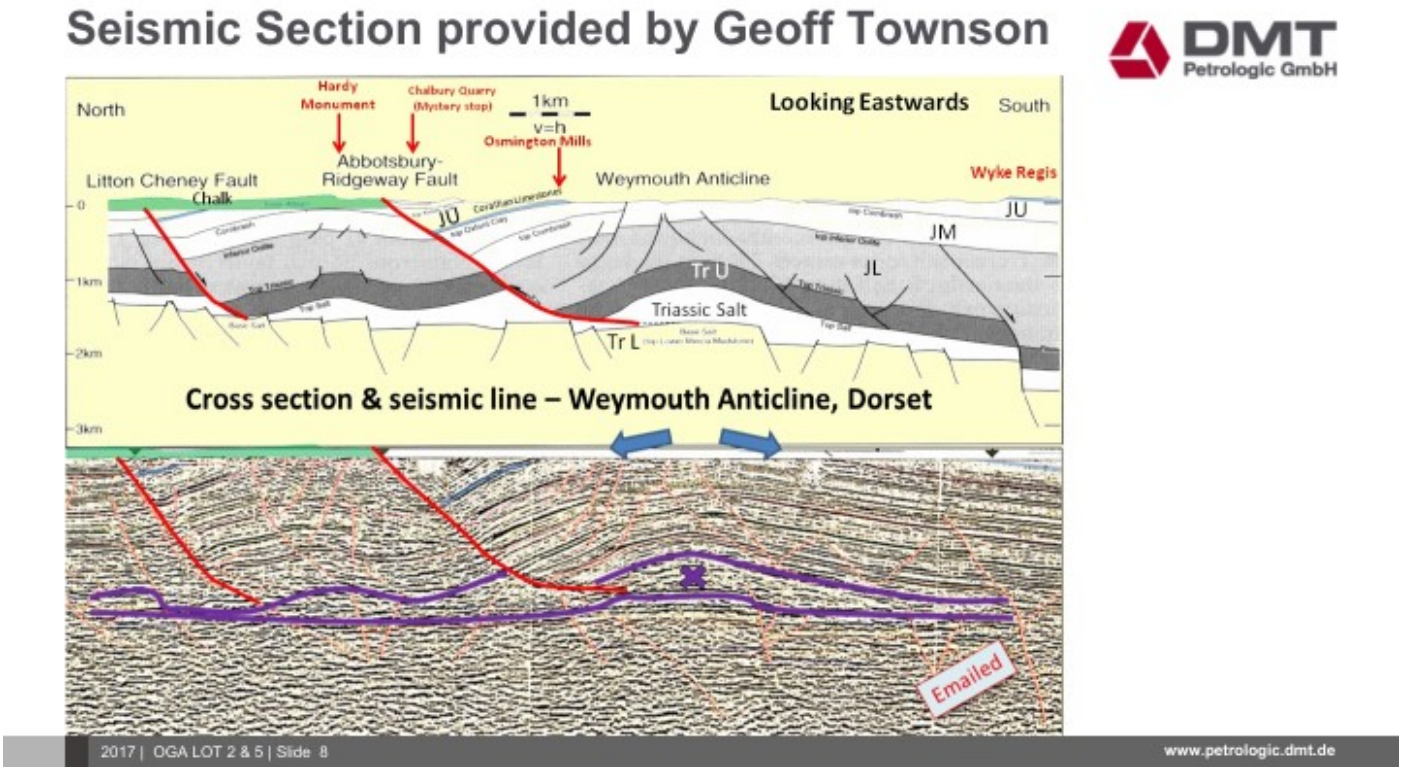
The landscape related to the geology is very varied and one example is probably best seen at Rocket Quarry, Portesham. Looking south towards Weymouth (over what is sometimes called ‘Weyland’) the scarp and vale landscape of the Weymouth Anticline is very obvious with ridges of limestone and sandstone and valleys of clay. The Weymouth Anticline is a dome shaped fold in the rocks caused by the effects of the Alpine Orogeny (mountain building episode) which occurred 25-30 million years ago and affected the south of England. Subsequent erosion has exposed the older rocks in the core (centre) of the fold and these are the Fullers Earth Clay (Frome Clay) seen around Langton Herring and the younger rocks (Portland and Purbeck Beds) on the limbs of the fold to the north and south. These are seen on Portland as well as on the south side of the Ridgeway such as at Upwey and Portesham. The two aerial photographs below show the view looking south towards Portland while the second looks east towards Upwey from near Corton.

In the second picture the Portland and Purbeck scarp is apparent with the Kimmeridge Clay valley on the right (south). The ridge is made up of a steep scarp slope to the south with a gentler dip slope to the north, related to the dip of the strata. The nature of the scarp is very obvious at Portesham especially if you take the minor road from Portesham north towards Winterbourne Abbas first climbing steeply and then dropping more gently after the turning to the Hardy Monument.

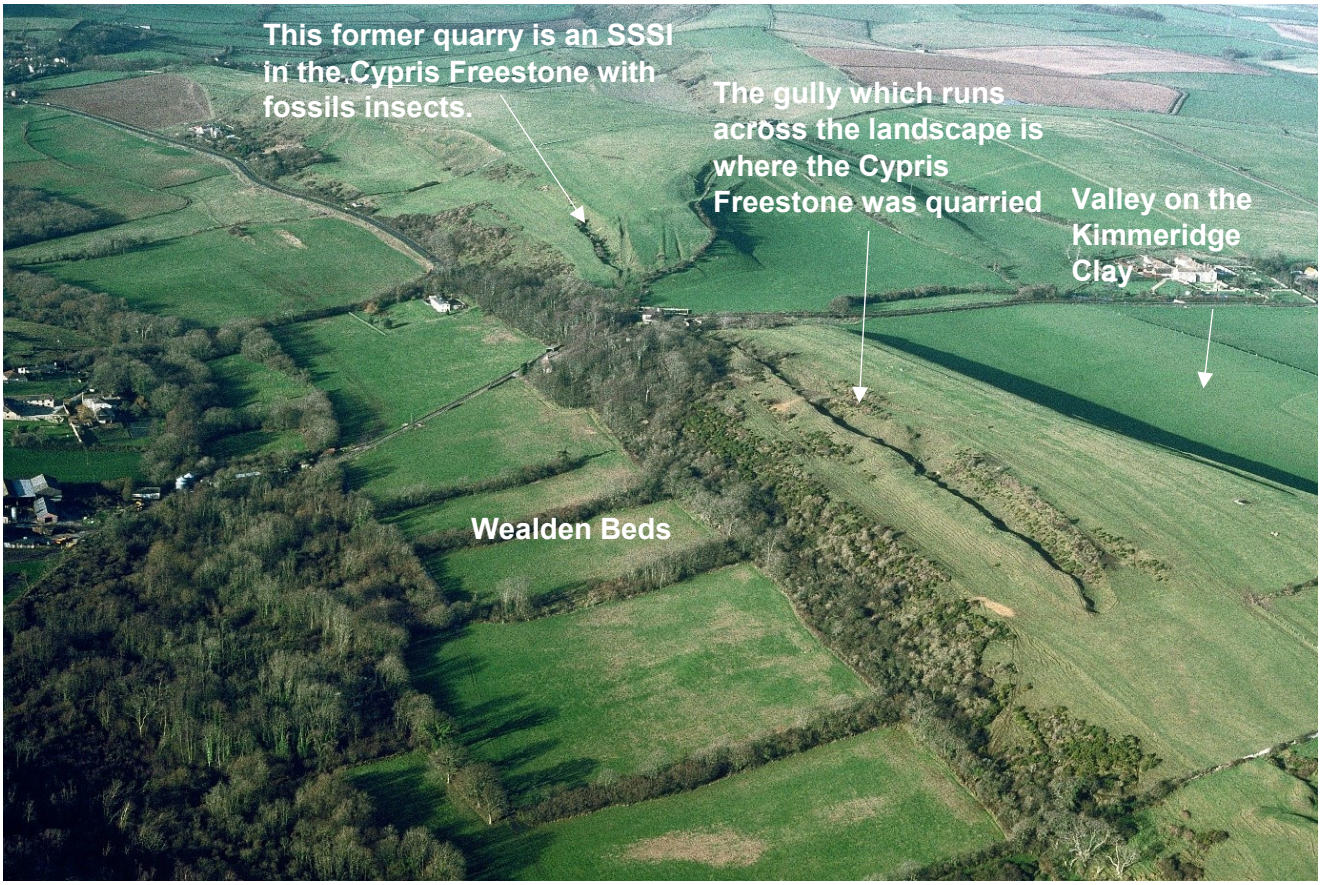


North south cross-section and relief map of Weyland.

Another method of showing the geological cross-section is through a seismic profile. This technique is used by the oil industry to identify potential geological structures which may produce hydrocarbons (oil and natural gas).



Another interesting anticlinal fold is located around Poxwell where a compact structure is seen in a feature known as a pericline. The strata dip away in all direction to produce a dome shaped structure. This is also an Alpine fold with an east west axis. The Kimmeridge Clay occurs in the core with younger rocks around from the Portland and Purbeck Beds up to the Chalk.



The aerial picture above is looking NW across the western end of the fold. Poxwell Manor can be seen on the extreme right, then a valley formed on the Kimmeridge Clay. Further south there is a ridge which has a scar running along it from former quarrying. This is on the Purbeck Beds (Cypris Freestone). Younger Wealden Beds are seen on the left of the picture forming lower lying land. The annotated picture below is on the northern side of the Poxwell pericline again showing ridges and valleys depending on the relative resistance of the rocks.

Chalk Landscape features.

Chalk tends to form higher areas of landscape with gently rolling hills. These are cut by dry valleys, valley forms with no streams or streams that only flow in wetter periods. The dry valleys were cut in the past often during the Pleistocene 'Ice Age' when during cold periods the ground was frozen (permafrost) and during warmer summer periods and inter-glacials snow and ice melted and the meltwater ran over the surface cutting the valleys. Following the Pleistocene in the Holocene period (present day) the permafrost melted, and the Chalk became permeable allowing rainwater to sink into the ground rather than run over the surface. The Chalk becomes saturated at depth below the water table. The water table moves down in dryer weather and up in wetter weather. The water table can reach the surface in wetter conditions resulting in a surface stream. These are often called winterbournes hence the prefix of some local village names (e.g. Winterbourne St Martin or Martinstown). The valleys may be floored by alluvium, sediment brought down by the streams and this is often clay and silt which is impermeable providing for pastoral farming.

Another characteristic feature of the Chalk areas is the thin rendzina type soils. Chalk is a very pure limestone and as it weathers at the ground surface very small amounts of insoluble mineral material are left. Flint is commonly left on the surface in this way. However, the thin soil will also contain other mineral grains and dark organic material (humus) from decaying plants. When looking across field surfaces the white partially weathered Chalk is seen. Despite the thin soil cover Chalk produces good conditions for extensive arable farming (as seen in the picture below looking south towards Maiden Castle) as well as pasture for grazing animals especially sheep.

Spring line settlements.

Another feature of the South Dorset Ridgeway area are spring line settlements. Villages were located historically where there was a reliable source of drinking water. This could either come from wells or where springs occurred. Examples of this include Portesham, Upwey and Sutton Poyntz. The springs occur where the water table comes to the surface. This maybe the result of a change of slope e.g. the base of a scarp or through a change in rock type from permeable to impermeable rock e.g. limestone over clay. At Portesham another geological factor comes into play, faulting. A fault can appear where rock movement has occurred in the earth's crust disturbing the rock creating

a fracture. In the case of Portesham the permeable Chalk is faulted against the impermeable Kimmeridge Clay giving rise to the spring at the northern end of the village. The stream then runs through the village over the Kimmeridge Clay down towards the B3157. The picture below shows the stream in the foreground with the Chalk scarp in the background.

Dolines.

These are depressions in the landscape a few metres or tens of metres across looking a bit like bomb craters. A number of these can be seen around the Hardy Monument area (as in the picture above) above Portesham and on Bronkham Hill to the S.E along the South Dorset Ridgeway footpath. The depressions occur where the Palaeogene (Tertiary) sands and gravels overlie the Chalk. Rainwater (which is slightly acid (pH 5.6) percolates through the sands and gravels probably becoming slightly more acid. This then dissolves the underlying Chalk and the sands and gravels collapse into the depression that the solution has formed. One of the largest examples is Cull-peppers Dish near Briantspuddle but this is outside the Ridgeway area.

More on the rocks of the area.

As mentioned above the rocks seen within the South Dorset Ridgeway area are all sedimentary and are Jurassic and Cretaceous in age with Palaeogene gravels around the Hardy Monument (GR SY 612875, DT2 9HY). The oldest rocks in the area are in the core of the Weymouth Anticline and seen around Langton Herring and exposed along the Fleet Shore (SY606813, DT3 4HZ). These are the Fullers Earth Clay also known as the Frome Clay. Next in the succession is the Forest Marble again seen along the Fleet Shore at Moonfleet (SY606815, DT3 4ED). Forest Marble has been used as a building stone in Dorset and further afield as it occurs in thin beds of broken shell limestone, cemented with calcite, which is impermeable Thinner beds are used for roofing and thicker beds can be used for walling and flagstone flooring. An example is shown below.

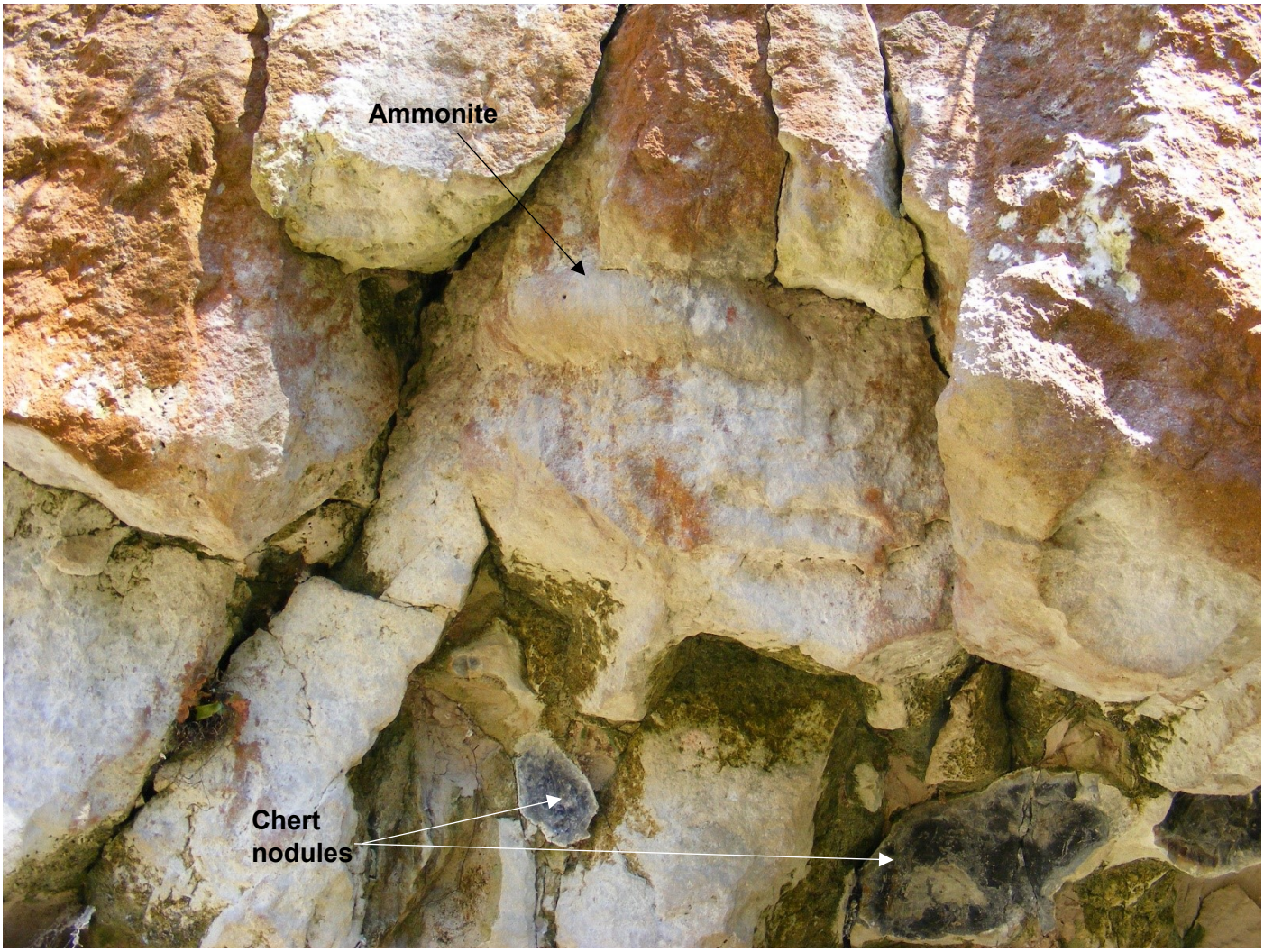
The next rock up the succession is the Cornbrash and then the Oxford Clay followed by the Corallian. This can be seen at Horse Pool Quarry, Abbotsbury (SY579846, DT3 4JH). The Corallian is a mixture of beds of limestone, clay and sandstone and the oolitic limestone is useful as a building stone. It can be seen in many buildings in Abbotsbury as well as St Catherine's Chapel (below).

The ooliths are clearly visible as are many bivalve shells. Oolitic limestone forms now in shallow tropical marine conditions such as those found in the Bahamas now and this gives an indication of conditions when these Jurassic rocks were formed 155 million years ago. At the Red Lane DIGS site oolitic ‘limestone’ can be also seen. However, it is very iron rich (ferruginous) and was worked as an iron ore briefly in Victorian times but it was found to be silica rich and not commercial as an ore. The silica was introduced during a geological change in the original rock called diagenesis. The picture below is of the iron rich oolitic rock with the remains of an ammonite.

The beds seen at Red Lane and elsewhere in the Abbotsbury area are known as passage beds between the Corallian and the Kimmeridge Clay.

The Kimmeridge Clay is a soft rock (mudstone or shale) and is rarely exposed inland and exposures on the coast are outside the South Dorset Ridgeway Project area (Ringstead and the Fleet around Ferrybridge). It forms the low-lying land immediately south of the Ridgeway as seen at Portesham Farm and Upwey. The Kimmeridge Clay is organic rich giving it a dark colour and in places the organic content is so high it is called an oil shale. It was dug out in Victorian times in the Portesham area to extract the hydro-carbons.

The Kimmeridge Clay is succeeded by the Portland Sand which is rarely exposed but forms the base of the scarp of the Ridgeway. It can be seen on the side of Corton Hill north of Coryates (GR SY622855, DT3 4HW) and at Corton Farm it is an SSSI. Higher up in the succession is the Portland Limestone which can be see at Rocket Quarry, Portesham, the Upwey road cutting and at Poxwell. The limestone is often oolitic indicating the shallow marine conditions mentioned for the Corallian. Part of the sequence has chert nodules, made of silica (and similar to flint in the Chalk). The chert makes the stone harder to work as a building stone but some beds are chert free and the Portland Limestone has been used widely in Dorset and further afield for buildings ranging from cottages to prestigious buildings such as St Paul's Cathedral thanks to the work of Sir Christopher Wren after the Great Fire of London in 1666. Local examples can be seen in Portesham, Upwey and Sutton Poyntz. One way to recognise Portland Limestone is through distinctive fossils especially the large ammonite Titanites which can sometimes be seen in exposures along the Ridgeway and at Poxwell seen in the picture below.



There are three main types of building stone from the Portland Limestone, Base Bed, Whit Bed and Roach. Base Bed is oolitic with little fossil material, Whit Bed has more broken shell debris while Roach is very fossiliferous with the bivalve Myophorella and the gastropod Aptyxiella. The latter is less popular as a building stone as it full of holes where the fossil shells have been dissolved away. However, it is used as an ornamental stone and can be seen in many locations in south Dorset and further afield. It is sometimes used as a facing stone on modern buildings (Beefeater and Premier Inn in Weymouth).

The Lower Purbeck Beds can also be seen at Poxwell and Rocket Quarry Portesham and the transition from a marine environment to a lagoonal /land environment is indicated by the presence of stromatolitic limestone formed by blue-green algae (cyanobacteria) and fossil soil horizons. Stromatolitic limestone has been formed on Earth since around 3500 million years ago (examples can be found in Western Australia). The best-known examples in the UK are probably those seen at the ‘Fossil Forest’ east of Lulworth Cove but similar examples can be seen at King Barrow Quarry on Portland as well as at Rocket Quarry. Unfortunately, it is rare to find the fossil wood associated with the stromatolitic rings that formed around the tree trunks when the water level in the Purbeck Lagoon rose killing off the trees. There is a stromatolite encrusted log to the west of Rocket Quarry which was extracted during quarrying in Victorian times. A fine example of a fossil log can be seen in the grounds of the Heights Hotel on Portland. The landscape north of the Rocket Quarry is pock marked with depressions where Cypris Freestone has been quarried. Careful study of the rocks along the Ridgeway may reveal other examples.


Stromatolitic
'pillow'


Fossil soil
horizon

Stromatolite encrusted log at Rocket Quarry.

Other exposures of the Purbeck Beds can be seen in the road cutting at Upwey on the west side of the A354 as well as in former quarries between the cutting and Gould's Hill north of Upwey Village. The three pictures above are from Rocket Quarry. Only the Lower Purbeck is seen at Portesham, but Lower and Middle Purbeck are seen at Upwey. The Purbeck Beds are less well developed in the west of Dorset than further east in Purbeck due to the latter being nearer the centre of the lagoon in which the sediments were deposited. One of the most useful building stones from the Purbeck Beds is the Cypris Freestone which was exploited at Portesham and along the Ridgeway to Poxwell (see the aerial picture of the Poxwell area). The limestone is largely made of millimetre size ostracods which lived in the lagoon in enormous numbers. The picture below is of Cypris rich limestone seen Portesham church.

Many local buildings were made of the Cypris Freestone and recently some stone was extracted at Poxwell for a conservation project on the Wolfeton Manor Riding House (Charminster) facilitated by the DIGS group. Also many buildings in Upwey village are constructed from Purbeck Limestone from the Winsbatch Quarry to the west of the village.

Part of the Purbeck Bed sequence seen at Upwey.

Above the Purbeck Beds are the Wealden Beds (of Lower Cretaceous age) but these are not well developed in west Dorset partly due to conditions when the sands and clays were deposited in lakes and rivers. The rock is soft and doesn't form major physical features in the landscape. There is a small outcrop at Upwey to the north of the A354 cutting but little can be seen.

In West Dorset part of the Cretaceous sequence is missing (what geologists call an unconformity) and if the rock was deposited it was later eroded before the later Upper Greensand and Chalk was deposited. Part of the sequence is also missing along the Ridgeway due to faulting (Abbotsbury and Ridgeway Faults). For example, if you walk north from Portesham Farm towards the Hardy Monument you cross the fault onto the Chalk but there is little to see as the rocks either side of the fault are of a similar hardness. Also, if you follow the A354 from Weymouth to Dorchester the cutting at Upwey doesn't show evidence of the fault. At the DIGS site at Bincombe, the boundary between the Upper Greensand and the Lower Chalk can be seen. Following on from the land conditions when the Wealden Beds were deposited the Upper Greensand was deposited in a shallow sea followed by the Chalk. This is indicated by the presence of fossils such as ammonites and brachiopods. The Chalk was formed in deeper water at a time when sea levels were very high and there was little land supplying sediment to the sea so the Chalk is dominated by micro-fossils called coccoliths that can only be studied using an electron microscope. The Chalk outcrops over a wide area but exposures are limited. However, there are many disused Chalk pits such as the DIGS site at Kingston Maurward.

After the Chalk was deposited sea levels fell and Dorset became a land area drained by a river system flowing from west to east. The river deposited sands and gravels in west Dorset now seen around the Hardy Monument and Thorncombe Wood / Puddletown Forest. The gravels are made of flint and chert pebbles and cobbles derived from the weathering and erosion of the Upper Greensand and Chalk. The picture below was taken on the south side of the Hardy Monument

The picture above is the view looking east from the Hardy Monument over the Chalk downland.

In places what are known as Sarsen Stones which are large boulders made of flint and chert pebbles in a silica matrix. As a result they are very hard and resistant to weathering and erosion. Examples can be seen in Portesham village along the stream, in the church yard and in the foundations of buildings at the northern end of the village.

The Sarsens were formed during tropical weathering in the warm climatic conditions of the Palaeogene. They were subsequently transported down slope off the hill tops by a process known as solifluction during the cold conditions of the Pleistocene. Frozen ground thawed at the surface during the warmer summer months and surface debris slumped down slope transporting the Sarsen Stones. The one in the picture weighs up about five tons! Another site where Sarsens can be see is in the Valley of Stones north of Portesham. Scores of large blocks can be seen in this National Nature Reserve.

From West Bexington to Abbotsbury the hillside from the Knoll (SY535879) passing Abbotsbury Castle (SY554867) has undergone large scale land slipping in the past, probably during Pleistocene cold events when solifluction and slumping occurred. Cretaceous strata (Gault Clay and Upper Greensand) rest on Fullers Earth Clay (Frome Clay) and Forest Marble. The impermeable rocks when wet are prone to slumping giving rise to the irregular landscape seen along the B3157 west of Abbotsbury.

Another feature seen on valley sides in the area are terracettes due to what is known as soil creep. Surface soil and weathered rock (regolith) move down slope very slowly (perhaps mm / year!) under the influence of gravity particularly on steeper slopes where the slope angle is greater than 30^0. Good examples can be seen in the valley north of Portesham and in the lower part of the Valley of Stones (pictures below).

For more information on the geology and landscape of the area it is recommended that you consult the web site of Ian West at

http://www.southampton.ac.uk/~imw/Ridgeway-Railway-Cutting.htm

For more information on the rocks and their use you should consult the Dorset Building Stone website which at the time of writing is still in a stage of development

http://dorsetbuildingstone.weebly.com/

Useful books include the Geologists' Association Guide No 22, Geology of the Dorset Coast by John C.W. Cope. ISBN 978 0900717 61 1

Dorset Stone by Jo Thomas. Dovecote Press. ISBN 978 1 904 34963 1

Geology of south Dorset and South-east Devon and its World Heritage Coast. B.G.S. ISBN 978 085272654 9

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