An Urban Geologist's Guide to the Fossils of the Portland Stone

The Portland seas were warm, full of nutrients and therefore full of life, and plenty of evidence for this can be seen on the walls of London's buildings. Good reviews and discussion of the geology of the Portland Stone are to be found in the excellent web pages created by Ian West (West, 2013, 2014) and in Cope (2012). An excellent treatise on Portland Stone as a building material has recently been published by Hackman (2014). The unit of uppermost Jurassic age, the Tithonian which is known locally as the Portlandian (Cope, 2012). Therefore these rocks are ~ 150 million years old. Stratigraphically, the building stones form the upper part of the Portland Limestone Formation and are called the Freestone Member. Marine reptiles such as pliosaurs and ichthyosaurs would have swam these seas, though their remains are rarely encountered in the stone. Varieties of bivalves are most frequently observed, along with coquinas of marine snail (gastropod) shells. The waters were relatively shallow, but tidal, they were lagoon-type environments. This environment brings about the formation of particles of carbonate sand known as ooids or ooliths. Ooids are spheroidal grains which form around kernals of fine sand grains or shell fragments. In the warm, tropical lagoons, tidal currents roll the grains backwards and forwards, and therefore the carbonate is precipitated concentrically to form ooids. These have a maximum size of around 1 mm diameter and are often visible with the aid of a hand lens, and sometimes the naked eye. Therefore the Portland Freestone is an oolitic limestone, with variable shell content. The Base Bed is relatively free of fossils. The Whitbed contains variable amounts of fossils, ranging from a few scattered oysters to cross-bed sections rich in shell detritus and even patch reefs, up to 3-4 m diameter composed of oysters or the coralline alga *Solenopora*. The Roach represents a shelly beach dominated by shell fossils, a coquina.



Above; a block of Roach placed on top of cross-bedded Whitbed at **23 King Street, W1**.

A major feature of some sections of the Portland Stone is the leaching of aragonitic shell material. We need to learn some carbonate geochemistry here to try to understand this process. Calcium carbonate is the main constituent of most limestones and also shell, corals and exoskeletons of other marine invertebrates. Calcium carbonate can exist in two forms or 'polymorphs' which have the same chemistry but different crystal structures. These two forms are called aragonite and calcite. Most shell-forming animals secrete aragonite as their exoskeleton. Aragonite is geologically unstable and usual changes to the geologically stable polymorph calcite during fossilisation. In the case of the Portland Stone, which was rapidly uplifted following its deposition, much of the aragonite has disappeared completely. This is because this formation rapidly lithified and the aragonite was dissolved away by meteoric waters in the freshwater environment of the overlying Purbeck Beds.

The line drawings used below have been adapted from Eric Robinson's handout 'Jurassic and Cretaceous Fossils', which in turn were adapted from illustrations presented in Arkell (1947). However it is always worth reminding ourselves that the faces of stones we see on buildings are artificial and therefore many

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sections through the fossils are observed and it is rare that perfect examples will be seen. Palaeontologists become adept at recognising all possible sections through a shell.

The Fossils

Gastropods - *Aptyxiella portlandica*, the 'Portland Screw'. This is the most iconic fossil of the Portland Stone, but it is only encountered in the coquina facies called the Roach.



Above: *Aptyxiella portlandica* on the new wing of **BBC Broadcasting House** on Great Portland Street.

The Portland Screw is a turreted, high-spired gastropod which is characteristic of and pretty much restricted to the Roach and so, as is typical in this facies, the aragonite shell has been leached away. This leaves 5-6 cm long (about the lengths of your fingers), arrow-shaped, external moulds of the shells and the spiral 'screws' which represent the internal casts of the shells. *Aptyxiella portlandica* is not found in mainland outcrops of the Portland Limestone Formation and so it can be considered as a truly diagnostic Portland beast, and characteristic of the Roach coquinas.

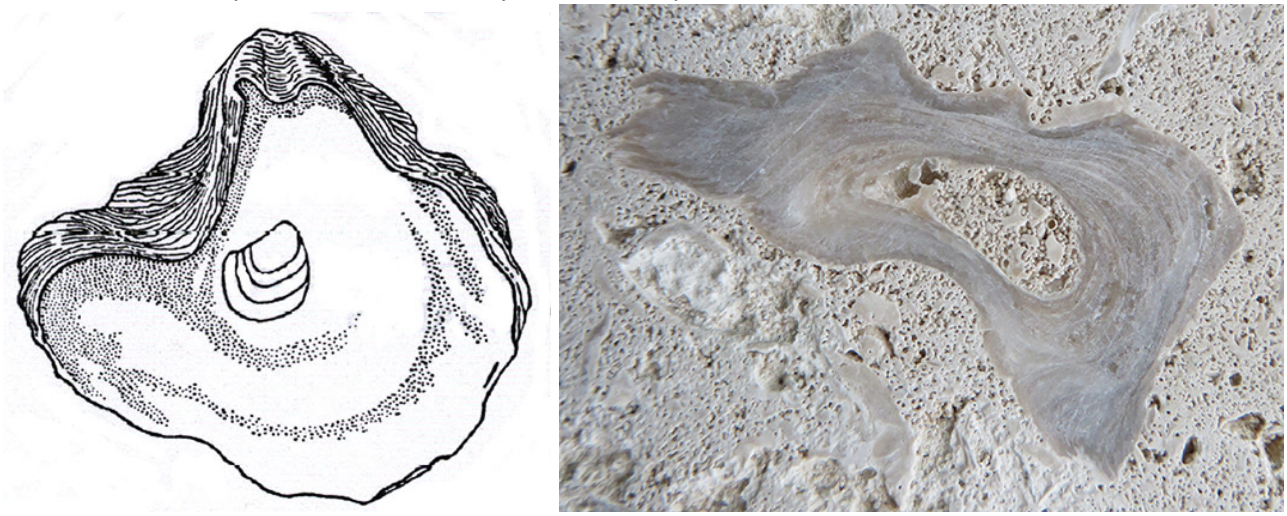


Above: Screw-shaped internal casts of *Aptyxiella portlandica*. These are not the body parts of the snail, but the carbonate mud which has filled in the shells. These examples are from **BBC Broadcasting House** on Great Portland Street.

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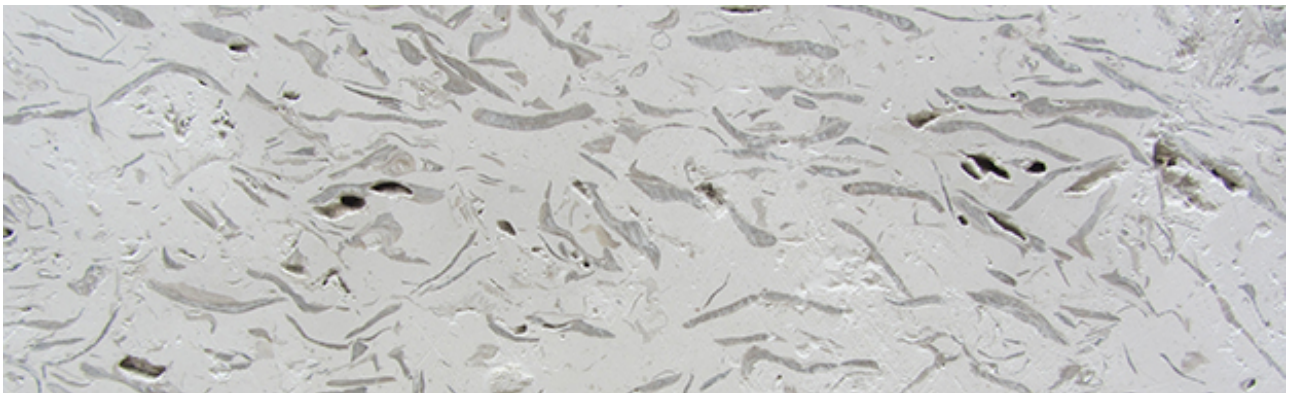
Bivalves

The commonest bivalve encountered in the Portland stone is the oyster *Liostrea expansa*. Oysters secrete calcite shells and they are therefore well preserved. Anyone who has ever seen an oyster shell on a beach or a dinner plate will know that they appear to be formed of thin layers of calcite, but anyone who has ever tried to crack one open will also know they are extremely robust.

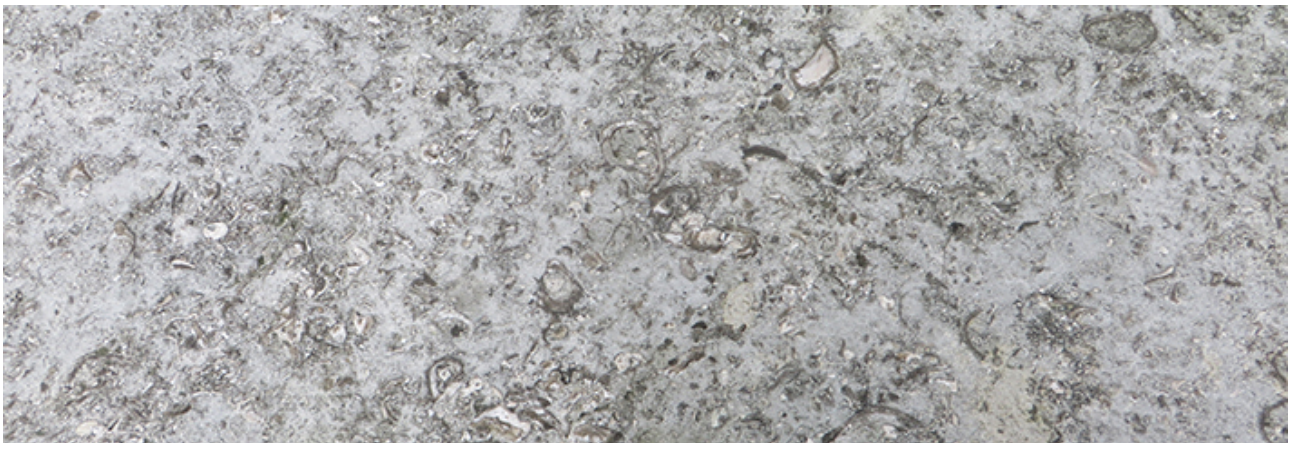


Above left; diagram of *L. expansa* after Arkell (1947). Right; a section through an oyster, probably cutting through close to the hinge of the shell, in Whitbed on **BBC Broadcasting House**. The finely layered structure of the shell can be clearly seen.

Oyster fragments are very commonly seen through the Whitbed and Roach, and indeed reef like masses of oysters developed in the Whitbed. The broken shells are also concentrated in lags in some varieties of the Whitbed as seen below at **Paternoster Square**.



Above: oyster shell lag in Portland Whitbed (Grove Whitbed). The field of view is ~ 20 cm. Below: an oyster-bed in weathered Whitbed used for benches at the **Economist Plaza**, St James's. This stone is cut parallel to bedding, FOV ~ 50 cm



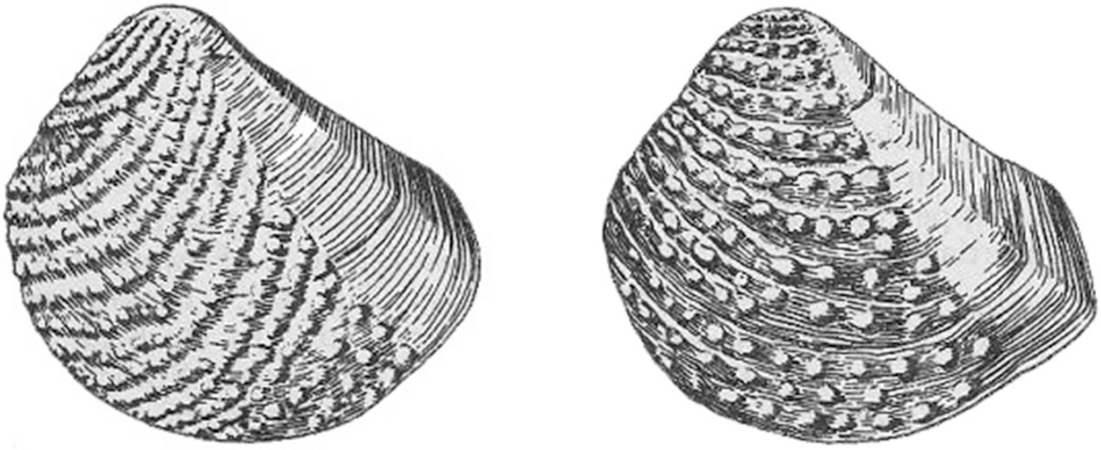
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Plicatula damoni, a variety of the spiny shells spondylus, are very similar to the oysters. They had thin ridges aligned concentrically along their shells which enabled them to anchor themselves in the mud. These shells are difficult to distinguish from oysters and pectens (see below) unless you can see these spine like ridges in cross section as in the example below, which shows both valves of the shell.



More often than not, *P. damoni* forms internal casts which are rather nondescript and they, unsurprisingly, resemble the fleshy parts of oysters in shape.

Trigonia shells are now largely extinct (there is one surviving variety that lives in one place in Australia). The species predominantly found in the Portland Stone is *Laevitrigonia gibbosa*. Trigoniid bivalves are thick-walled shells, which means that they were able to withstand high energy environments. The shells are also typically highly ornamented with ribs and knobs, the latter technically referred to as costae (singular: costa). The commonest variety found in the Portland Freestone is *Laevitrigonia gibbosa*, which has two forms one with ribs and the other with costae.



Above: varieties of *L. gibbosa* after Arkell (1947).

Typical of the Roach, the aragonitic shells of *L. gibbosa* have been dissolved away, leaving external moulds which show the shell surface ornamentation. Also present are the internal casts which replicate the form of the interior of the shell. These are given their own Latin name *Myorphorella incurva.* It is not hard to imagine how these casts can become detached. On their own these odd looking fossils are known as 'steinkern', literally stone hearts. Similar trigoniid casts to *M. incurva* were termed hippocephaloides by 17th Century natural historian Robert Plott because they resembled rather mournful horses heads. However to the Portland quarrymen they became known as 'osses' 'eads (horses heads) in the local vernacular. Images of these and Plott's drawing can be seen on the Natural History Museum's website[1].

[1] http://www.nhm.ac.uk/nature-online/earth/fossils/fossil-folklore/fossil_types/bivalves02.htm

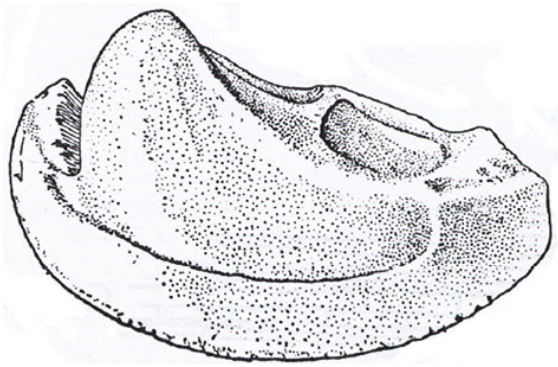
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Above: Moulds of *L. gibbosa* in Roach at **BBC Broadcasting House**. These examples show good detail of the ornamented shell surfaces. Each shell is about 5 cm across. Below: moulds and an internal cast of *L. gibbosa* clearly showing the costae on the shell surfaces.



Below is a drawing of a perfect *M. incurva* (after Arkell, 1947). The image on the right (FOV ~ 15 cm) shows more typical casts (as well as a *Trigonia* shell mould).



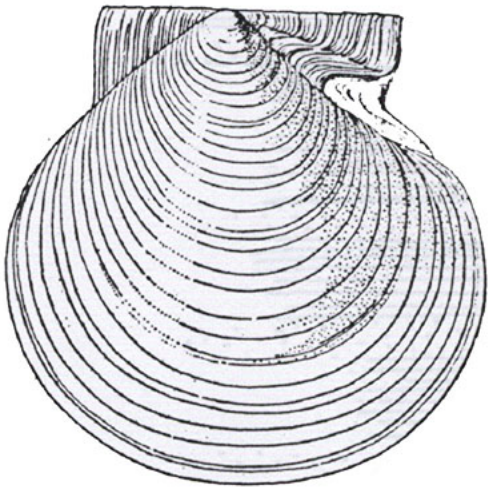


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Left: Two sections through once articulated valves of *L. gibbosa*, now leached away. By chance, the mason has cut through along the long axes of the shells giving the effect of 'angel wings'. The ribs and costae can be seen on the upper example of the two. Once again, this is from the Roach used on the new wing of **BBC Broadcasting House.** Right: An 'osses 'ead in a sample of Portland whitbed from Jordans Bowers Mine on the Isle of Portland.

Camptonectes lamellosus is a variety of pecten. Pecten are scallop shells and characteristically have well developed 'wings' along their hinge. The variety are extremely common along some beds of the Portland Stone. They are frequently well preserved as they, like oysters, precipitate calcite and not aragonite. The shells are around the size of modern edible scallops.




Above left; diagram to show the appearance of the whole of *Camptonectes lamellosus* shell (after Arkell, 1947). Right; half a pecten with one of the 'wings' preserved at the end opposite my finger. This example is on the front steps of the Slade School at **University College London**.

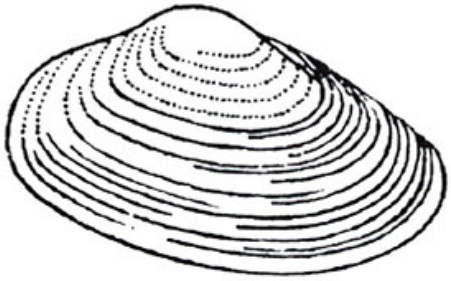
Pairs of articulated valves of *C. lamellosus* are often seen in the Whitbed. They can be distinguished from the spondylus described above by the lack of spines and the flattening of the hinge zone. Unlike modern edible scallops, which have one flat and one convex valve, *C. lamellosus* has two convex valves.

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Above: a cross section of *Camptonectes lamellosus* in Whitbed on **BBC Broadcasting House**. FOV ~ 12 cm.

Also present on Whitbed and the Roach are the mussels *Mytilus suprajurensis*, tellin shells *Pleuromya tellina*, the rock-boring bivalve *Lithophaga* and varieties of cockles including *Protocardia dissimilis*. These are less easy to distinguish as they are often fragmentary. The oyster-like, but aragonite precipitating *Isognomon listeri* is also known from the reef-forming facies, predominantly as internal moulds (West, 2014, Townson, 1975).



Left: *Pleuromya tellina.* These shells are ~ 2 cm across.

Ammonites

Ammonites, spiral shells occupied by squid-like creatures are classic Mesozoic fossils. The giant ammonite, *Titanites anguiformes,* is the classic fossil of the Portland Stone, though they are rarely observed in building stones, and if they do they are generally fragmentary. Whole specimens are up to a metre across. Another species, *T. giganteus*, of similar dimensions also occurs but is less abundant than *T. anguiformes* (Wimbledon & Cope, 1978).



Above: images of *Titanites anguiformes* (left) and *T. giganteus* (right). Both specimens are ~ 1 m diameter (adapted from Wimbledon & Cope, 1978).

Visitors to the Isle of Portland can observe a great number of these fossils set into walls. They were called 'Conger Eels' by the quarrymen. Indeed a theory as to why *T. anguiformes* is rarely encountered in building stones, is that when they are found, they are kept as prizes by the quarrymen. Good photos of good specimens can be seen on Ian West's website[2]. It is certainly true that there are few examples to be found

[2] http://www.southampton.ac.uk/~imw/jpg-Portland/11PT-Albion-Ammonite-Roach.jpg

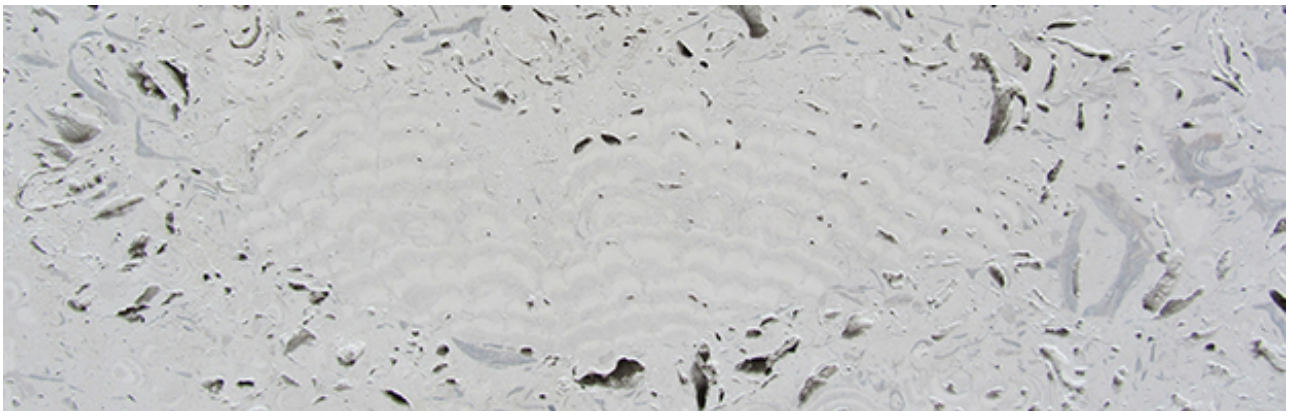
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in London building stone. An example can be found on the front steps of the Slade School of Fine Art at **University College London**. Here the paving slabs take several slices through the same fragment of a whorl.



Alga

The red algae *Solenopora portlandica* formed small patch reefs in the Portland Stone seas (Fürsich et al., 1994). They are not particularly common, but when encountered by quarrymen, they are quarried as a coherent stone for use in a single project. A good example of such a use is at **Caxton House**, Tothill Street SW1. These reefs are dominated by *Solenopora*. However, white fragments of *Solenopora* are common throughout the more shell-rich varieties of Portland Stone and those formed in more dynamic environments. They resemble in size and shape cauliflower florets and show distinctive growth rings, which sometimes show preferential weathering of alternate bands. These are believed to represent seasonal phases of growth (see Wright, 1985).



Above: Solenopora 'floret' with seasonal growth rings in Portland Whitbed observed in **Paternoster Square**.

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Above: Solenopora weathering out on the parapet of **Waterloo Bridge.** FOV 5 cm.



Above: Solenopora reef facies at **Caxton House**, Tothill Street, SW1. FOV ~ 20 cm.

West (2014) has also identified the bryozoan *Hypororpora portlandica* encrusting shells in these reefs.

Trace fossils

Trace fossils are the preserved marks made by feeding or moving organisms on sediment. These are common in the Portland Stone, but are often subtle and difficult to see. The most frequently encountered

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are burrows which can be formed by a number of organisms but primarily crustaceans, These are called *Thalassinoides*. These burrows vary in size from 2-3 cm in diameter to much larger (10 cm) burrows and they may be infilled with shell debris and carbonate mud. Typically *Thalassinoides* are a branching network of burrows and structures resembling a double-ended Y are common throughout the Portland Stone Formation (see Townson, 1975). These burrows are orientated sub-parallel to bedding.



Above: Thalassinoides burrows in Portland Stone Whitbed. The steps of the Kathleen Lonsdale Building at **University College London.**

Other traces of organisms can be found from their circular or ovoid borings into shells and sediment. Those in oyster shells or reef facies are most obvious and were formed by worms (i.e. *Glomerula* sp., Townson, 1975), sponges and the rock-boring bivalve *Lithophaga* (also known as date mussels – modern varieties do resemble date fruits). This shell characteristically lives in shallow water or the littoral zone.



Above: Left; pellet of oyster reef bored by the bivalve *Lithophaga* sp., forming the ovoid structure in the upper centre. Right: brings in oyster shells by sponges or worms. Both examples are on **BBC Broadcasting House**.

Vertebrate Fossils

Bones are rarely seen in Portland building stone, but Delair & Wimbledon (1993) record several varieties of Late Jurassic reptiles from the building stone member and equivalent strata, including crocodiles, turtles, *Ichthyosaurs*, *Pleisiosaurs* and saurischian dinosaurs including Jurassic Coast favourites *Megalosaurus* and

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Iguanodon. I am also reliably informed by Mark Godden of Albion Stone that bones and teeth are occasionally found in the quarries (Godden *pers. comm*. & also see Godden, 2012). A fine example of a turtle, found by Diane Godden, can be seen in the Portland Museum. Smith & Martill (2025) have published the mandible of a pterodactyl found in Jordans Mine and subsequently acquired by the Natural History Museum.

The only example I have encountered in London's building stone is in the City of London, where a small bone fragment is seen in a slab of Jordan's Whitbed used as cladding on a building façade.



Read more about Portland Stone and its fossils …

Arkell, W.J., 1947, The Geology of the Country around Weymouth, Swanage, Corfe and Lulworth. Memoir of the Geological Survey, HMSO, 386 pp.

Cope, J. C. W., 2012, Geology of the Dorset Coast; Geologists' Association Guide No. 22., Chapter 5, South Dorset; Isle of Portland, 94-103.

Delair, J. B. & Wimbledon, W. A., 1993, Reptilia from the Portland Stone (Upper Jurassic) of England: A preliminary survey of the material and literature., Modern Geology, 18, 331-348.

Fürsich, F. T., Palmer, T. J. & Goodyear, K. L., 1994, Growth and disintegration of bivalve dominated patch reefs in the Upper Jurassic of Southern England., Palaeontology, 37 (1), 131-171.

Godden, M., 2012, Portland's quarries and its stones. http://www.dorsetgeologistsassociation.com/Portland-Stone/Portland_Stone_Document_-_7_June_12.pdf

Hackman, G., 2014, Stone to build London: Portland's legacy., Folly Books Ltd., Monkton Farleigh., 311 pp.

NHM Fossil Folklore: Bivalves; http://www.nhm.ac.uk/nature-online/earth/fossils/fossil-folklore/fossil_types/bivalves02.htm

Portland Museum: http://www.portlandmuseum.co.uk

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Smith, R. E. & Martill, D. M., 2025, A ctenochasmatid pterosaur from the Portland Limestone Formation (Late Jurassic, Tithonian) of southern England., Proceedings of the Geologists' Association., (*in press*) https://doi.org/10.1016/j.pgeola.2025.101100

Townson, W.G. 1975. Lithostratigraphy and deposition of the type Portlandian. Journal of the Geological Society, London, 619-638.

West, I. M. 2013. Fossils of the Portland Group, Upper Jurassic: Geology of the Wessex Coast (including the Dorset and East Devon UNESCO World Heritage Coast - Jurassic Coast). Internet field guide. Version: 26th August 2014.; http://www.southampton.ac.uk/~imw/portfoss.htm

West, I. M. 2014. The Isle of Portland: General. Geology of the Wessex Coast (part of Jurassic Coast, Dorset and East Devon World Heritage Site). Internet field guide. Version: 24th August 2014. http://www.southampton.ac.uk/~imw/Portland-Isle-Geological-Introduction.htm

Wimbledon, W.A. & Cope, J.C.W. 1978. The ammonite faunas of the English Portland Beds and the zones of the Portlandian Stage. Journal of the Geological Society, London 135, 183-190.

Wright , V.P. 1985. Seasonal banding in the alga Solenopora jurassica from the Jurassic of Gloucestershire, England. Journal of Palaeontology, 59, 721-732.

London Buildings with good and varied examples of Portland Stone

Portland Stone, in various stages of weathering, can of course be seen all over London. The examples below are chosen to best show the fossils.

Caxton House, Tothill Street SW1 – The building is clad in stone from a *Solenopora* patch reef.

BBC Broadcasting House, Great Portland Street W1 – On the new extensions of this building, excellent 'exposures' of Roach and Whitbed can be seen.

Economist Plaza, St James's Street SW1 – The building which introduced Portland Roach as cladding.

Green Park Tube Station, Piccadilly SW1 – most varieties of Portland Stone are used here. The station also display's John Main's work 'Sea Strata' which illustrates giant size Portland Fossils.

New Stock Exchange, Paternoster Square EC4 – this and other buildings in Paternoster Square show god examples of Whitbed varieties.

St Margaret's Westminster – a vertebrate bone on the SE corner of the church.

UCL Front Quad, Gower Street WC1 – This is a good an accessible place to see weathered Whitbed and the ammonite on the front steps of the Slade School (north end of the quad).

Waterloo Bridge SE1 – The bridge is built from a cross-bedded variety of Whitbed, rich in shell fragments and *Solenopora* debris.

MeHotel Strand WC2 – the building is clad with fossil-packed Coombefield Whitbed.

How to cite this article:

Siddall, R., 2025, An Urban Geologist's Guide to the Fossils of the Portland Stone, v2, Urban Geology in London No. 30, 12 pp., http://ruthsiddall.co.uk/Walks/PortlandFossils.pdf

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