The Street Geology of Queenhithe

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This short walk along Upper Thames Street, EC4, and the north embankment of the Thames from Southwark Bridge to the Millennium Bridge links Eric Robinson's walks around Southwark (Robinson, 1993) to St Paul's Cathedral (Robinson & Bishop, 1980). However it takes in a series of buildings with an wide and geologically interesting selections of stones. The interiors of Vintner's Place and Thames Court are also of geological interest.

Queenhithe is the inlet on the left, on the other side of the quay are Thames Court and Vintners Place.

The quay at Queenhithe is 800 years old and was one of the most important landings on this stretch of the Thames until it was superseded by Billingsgate in the 15th Century. Nevertheless, it continued in operation until the 20th Century. It is named after Queen Matilda, wife of Henry I, who opened London's first public toilet on this site in the 12th Century (Weinreb *et al*., 2010).

The walk starts at Vintners Place, EC4V 3BJ, on the north end of Southwark Bridge. Steps on the west side of the bridge take pedestrians down to the embankment in front of Vintner's House.

Vintner's Place, 68, Upper Thames Street.

With its rather brash, neoclassical façade in white stone, Vintners Place was the height of early nineties style. Built in 1992, it was designed by architects The Whinney Mackay - Lewis Partnership to house offices. Although not to everyone's taste, the building uses a range of interesting stones both for its interior and exterior. The entrance to the building is at 68, Upper Thames Street, however it is not open to the general public. Nevertheless the stones used in the exterior are well observed both on the street front and along the Thames path on the embankment at the rear of the building. The exterior stone cladding was contracted by Grants of Shoreditch, whilst the interior stone was supplied by Furrer Carrara. Vintner's Place envelopes the older building of Vintners Hall. The entrance on Queen Street Place is of Portland Stone, and sports a

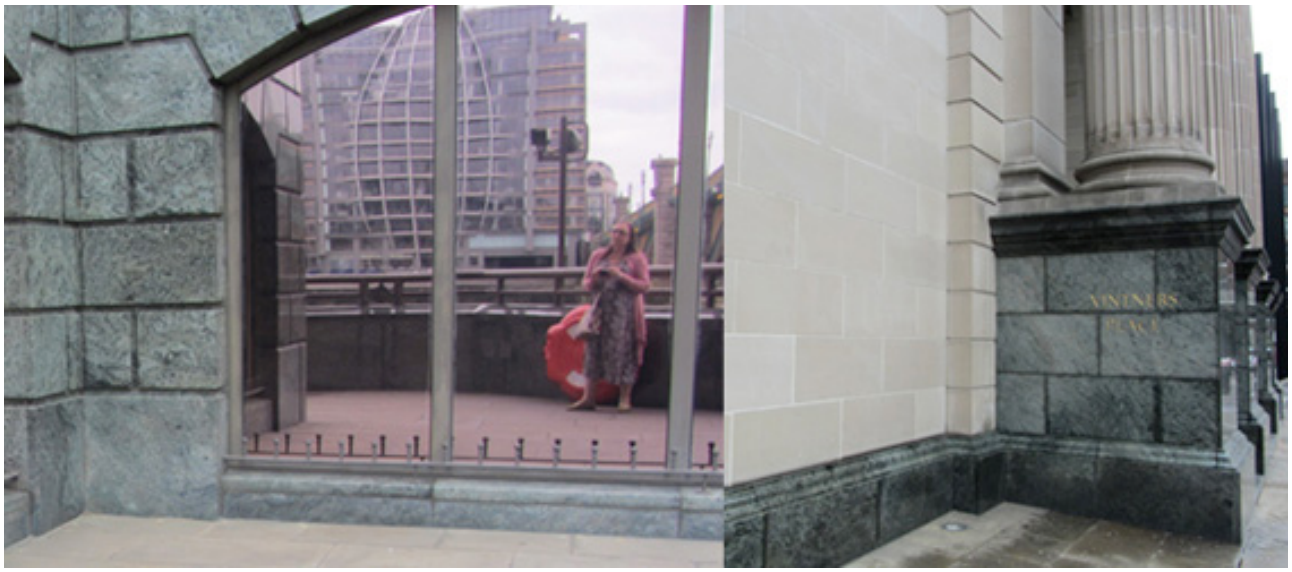
fine carving of a bacchante with goats by Herbert Palliser. Take the steps down to the Thames River Path.

The foundation course of Vintner's Place, best observed on the rear of the building on the embankment, is of a green orthogneiss called Verde Candeias or Verde Maritaca. It is from the Campo Belo Metamorphic Complex and is quarried from several sites between the towns of Campo Belo and Candeias in the state of Minas Gerais, Brazil. It is an ancient and unusual rock which has become very popular as a building stone (Price, 2007). Verde Candeias is a migmatitic gneiss which has been dated to 3 billion years with an unusual composition and complex geological history (Texeira et al., 1998; Oliveira et al., 2001). It belongs to a suite of rocks called charnockites which are Archaean pyroxene-bearing granitoids. Pyroxene would be unexpected to occur in more recent granitic rocks. This rock is a pyroxene-bearing granodiorite, an 'opdalite' with orthopyroxene, quartz, plagioclase, biotite and red garnet. The colour is enhanced by the presence of the green minerals chlorite and epidote. Since it was formed 3000 million years ago (3 Ga), it underwent peak metamorphism at 2.7 Ga. Its swirly texture is the result of this rock being metamorphosed at such high temperatures that it became extremely ductile and partially molten, producing a rock known as a 'migmatite'.

Vintner's Place, rear elevation facing the Thames.

Walk around to the front façade of Vintner's Place on Upper Thames Street, where the stone cladding the upper stories of the building is observable at pavement level. The upper courses of the building are clad with a white limestone which at first glance may be dismissed as London's standard Portland Stone. However it is built not with England's monumental building stone of choice, but the USA's. This is Indiana Limestone which is worked from several quarries along the outcrop in Monroe and Lawrence Counties in the state of Indiana. The geological name of this rock is the Salem Limestone Formation and it is of Mississippian (Lower Carboniferous) age. It is a medium-coarse grained, cross-bedded, buff calcarenite, also rich in ooids. It contains a variety of

fossils; bryozoans, brachiopods, pelecypods and crinoids. It was deposited on a warm, tropical continental platform, with shallow, fully marine conditions, distant from clastic sediment sources (Williams, 2009). This stone was the building of choice for practically every US town hall and post office, and many of the monumental buildings of Washington D. C. feature this stone. Although used locally in Bloomington and elsewhere in Indiana from the 1820s, the stone became widespread in its use after the coming of the railways to the USA in the 1850s. It is a stone not commonly seen in the UK.



Vintner's Place: Left, Verde Candeias clads the foundation courses of the building. Right, Verde Candeias with Indiana Limestone above.

Unfortunately the interior of the building is not open to the general public, but a peak through the glass doorway or windows reveal a lavish, Renaissance-style, interior with floors inlaid with decorative marbles and limestones. Some images are available on the stone contractor's website (see the link for Furrer Carrara below) and it may be possible to visit the lobby with permission from the reception. The following stones are used:

Bianco Carrara Campanili: A white, hard compact calcite marble from the Alpi Apuane Hettangian Marble Series in the district of Massa e Carrara. The name is said to derive from the fact that it rings like a bell when struck with a hammer.

Breccia Pernice: A Liassic (Lower Jurassic) pink, carbonate breccia from the Verona area of Italy.

Botticino: A cream-ivory coloured, bioturbated, sublithographic limestone of Jurassic age. It comes from Mazzano in Lombardy, Italy.

Crema Valencia: An orange-yellow limestone, flushed with pink, with irregular, stylolitic, dark-red veins (hematite infilled). It is Maastrictian (upper Cretaceous) in age. The stone is derived from a single quarry near Barcheta in Valencia, Spain.

Emperador Dark: Also known as Marrón Emperador, it is a chestnut brown, translucent, brecciated dolomite, cut through with veins of calcite. The degree of brecciation varies from 'mosaic' to 'crackle'. It is a Cretaceous limestone from Jumilla in the province of Murcia, Spain.

Estremoz: A variety of pink, white and variegated marbles come from the Estremoz Anticline in east-central Portugal. They are Ordovician limestone metamorphosed during the Devonian

(Carvalho et al., 2008). A pink variety is used here, the pink marbles occur as lenses in otherwise cream and white marbles. These marbles have been quarried since the Roman period.

Giallo Siena: A calcite marble coloured yellow by goethite. It contains abundant stylolites concentrating dark purple iron oxides and is veined by white calcite. It is a Jurassic limestone, metamorphosed in the Eocene. It comes from quarries on Montarrenti, near Siena in Tuscany, Italy (Jervis, 1862; Renwick, 1909).

Rojo Alicante: Also known as Rosso Alicante, this is a Jurassic, bright orange-red nodular limestone, cut through with white calcite veins and infilled vugs. It comes from La Romaneta Quarries, Monte Cavarrasa, in southern Spain.

Statuario Venato: Also from the Carrara region, Statuario Venato is a white marble networked with diffuse, grey veins.

Verde Acceglio: From the hamlet of Acceglio, in the Piemonte, Italy, this is a serpentinite from a small ophiolite body intercalated with the Schistes Lustres of the Cottian Alps (Schwartz et al., 2000). It is a green serpentinite breccia networked with white calcite veins.

The main stones used in the floor are Botticino and Campanili, with the others used as coloured inlay. Many of these stones are considered 'classic' marbles and further information about them, in addition to references given above, may be found in Price (2007) and for the Spanish stones in Perrier (1992).

The Lobby of Vintner's Place: 1.Statuario Venato, 2. Botticino, 3. Crema Valencia, 4. Rojo Alicante, 5. Breccia Pernice, 6. Verde Acceglio & 7. Bianco Statuario Campanili.

Thames Court

Next door to Vintner's Place on Upper Thames Street is Thames Court by architects Kohn Pedersen Fox Associates was built completed in 1998. It is a multi award-winning building, and it is the complete opposite in so many ways to it's neighbour. Thames Court is stylish, restrained and is clad, both interior and exterior in British stones.

The vertical pillars along the Queenhithe façade are easily examined. They are clad in contrasting red and yellow stones. The yellow stone is Ham Hill Stone from Montacute, near Yeoville in

Somerset. It is a buff to golden yellow coloured calcite-cemented, bioclastic limestone, aragonitic shells have weathered out. It is part of the Lower Jurassic, Lias Group and was deposited in channels cut through the underlying Bridport Sands, and is consequently cross-bedded. Ham Hill Stone has been quarried since the Roman Period (King, 2011). When first extracted it is soft and hardens with exposure to air. It is damaged by air pollution and the few London buildings built of the stone during the 19th Century suffered badly (i.e. 100, Piccadilly, see Robinson, 1985). However the cleaner air of the 21st Century are not a problem and the stone is becoming popular for inner city buildings once again.

Thames Court, Queenhithe: red Corsehill Stone and yellow Ham Hill Stone clad the pillars on the exterior.

The contrasting and complementing stone is red Corsehill Stone from Dumfrieshire. It is a bright orange-red, thick-bedded, cross-bedded, fine grained, micaceous sandstone. These are from the Triassic Annan Sandstone Formation, fluvial channel sands deposited on a braided river floodplain, equivalent in age to the St Bees Sandstone of west Cumbria. The Annan Sandstone was also known to have been worked by the Romans and inscriptions have been found in ancient quarries. Commercial production began in the 18th Century. According to Brookfield (2004), slabs of Annan Sandstone, taken to America as ballast, were used to pave George Washington's kitchen at Mount Vernon. Corsehill Quarry has been worked since at least the 19th Century, with the peak of activity in the 1880s. It supplied stone for Liverpool Street Station. The quarry closed in the 1940s but was reopened in 1982 by Cumbrian Stone Ltd.

Returning to Upper Thames Street, the interior of the building can be observed through the windows. Access is possible when the café is open. However the floor paving extends to the exterior of the porch and so can also be examined when the building is closed. The paving stone is Purbeck Cap, a blue-grey to olive coloured micritic limestone from Dorset. Slabs show bioturbation and dessication cracks. The Early Cretaceous Purbeck Group is a series of thin beds of limestones, mudstones and calcareous clays laid down in a shallow freshwater to brackish and marine environments, with the climate changing from semi-arid to humid upwards. Fossils of mammals, reptiles, insects and plants have been found, indicating a terrestrial, freshwater environment.

However, most of the beds are dominated by a fauna of freshwater mussels. The various limestone beds were known as 'veins' by the local quarrymen. Cap is from the Mupe Bay Member of the Lulworth Formation of the basal Purbeck Group (Westhead & Mather, 1996).

Purbeck Cap paving at Thames Court.

An information board by the dock describes the long and interesting history of the Queenhithe wharf. It is not possible to walk around the perimeter of Queenhithe, so return to Upper Thames Street, turn left and follow the road until it is possible to access the Thames River Path again at Broken Wharf. On the left is Broken Wharf House.

Broken Wharf House

Left: Broken wharf House; Right: Channel cross bedding in the sandstone (upside down!).

Broken Wharf House is faced with a beautiful, dark red, cross-bedded sandstone. Unfortunately this stone has not been identified. It is probably a British sandstone belonging to the Permian New Red Sandstones. Apparently of fluvial origin, the stone shows good examples of channel-cross bedding, although not all slabs are applied to the building the 'right way up'!

Continue along the Thames River Path to The complex of buildings which ends with Millennium Bridge House. All are faced with the same stone.

1, Millennium Bridge

The post-modernist building of 1, Millennium Bridge is faced with a very coarse grained, megacrystic, yellow-coloured granite. This is known variously as Golden Carioca or Giallo Dorato and it comes from the state of Minas Gerais in Brazil.

The colour is in fact superficial. Yellow iron-oxides coat the rims and penetrate the cleavage in the feldspars. This is the result of tropical chemical weathering and diminishes with depth within the granite pluton, the staining fades away at depths of around 200 m. The granite is extracted from quarries in the Pedro Azul Pluton, one of many late Proterozoic intrusions emplaced during the Araçuaí Orogen (Pedrosa-Soares et al., 2011). As well as being extensively worked as building stones, these granites are also important sources of gemstones from their associated pegmatites, particularly topaz and aquamarine.

Left: Millennium Bridge House, Right: Golden Carioca granite, field of view is 10 cm.

This is the end of this walk. From the Millennium Bridge, it is a 5 minute walk from St Paul's Underground Station.

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