

A fire-spitting volcano in Deptford? Urban Geology in Southeast London

Ruth Siddall



No, there are no volcanoes in Deptford, and there have probably never been any throughout at least the last 1000 million years. The title of this urban geological walk comes from an observation of an astonished and bewildered resident of the Gleichburg in Germany who may (or may not) have witnessed a volcanic eruption there in the 18th Century (see Grattan et al., 2000). In February 2017, SmashFest UK celebrated volcanoes and all things volcanic in their community science festival based in Deptford, south east London. Part of this event included a geological tour of the area's (mainly) igneous rocks, used as paving, street furniture and building materials. This is a write up of that tour with the additions of a few other local buildings worthy of geological interest. The walk starts at the Albany Theatre on Douglas Way, SE8 4AG.

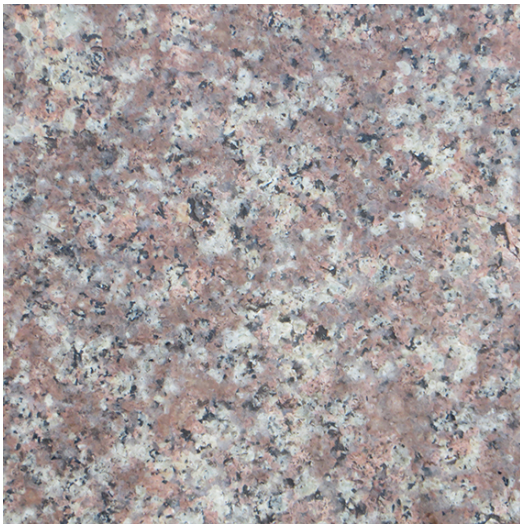
From the main entrance of The Albany, turn left and then left again crossing the market place into Deptford Market Yard.

Deptford Market Yard

The redevelopment of Deptford's Market Yard and the impressive Victorian Carriage Ramp was undertaken by Farrer Huxley Associates in 2015. The Ramp itself was designed and built from brick by Colonel George Thomas Landmann (1780-1854) of the Royal Engineers in 1835. The London & Greenwich Railway was London's first railway line, opening in 1836 and passengers were carried on an elevated line, hence the requirement for an access ramp. The line ran from Greenwich to London Bridge, and Deptford was the first stop. The 2015 redevelopment has placed shops and cafés in the Ramp's arches and has paved the Yard to make a very pleasant place for socialising on the way to and from the station. The Market Yard has been paved with a range of Chinese granites and related rocks which are very popular for city paving at present; mainly because they are available in large quantities and are relatively cheap, whilst being hard-wearing and attractive. Granites are igneous rocks; those that have crystallised from the solidification of a melt and

can form in many environments within the Earth's crust. They are 'Plutonic' rocks rather than 'Volcanic'. Named after the Greek god of the underworld, Pluto, granites crystallise from a 'magma' underground, usually at depths of 5 or more kilometres. Some granites can occur at much shallower depths and these can be the magma chambers that feed volcanoes and are the source of 'lava' which is liquid on the Earth's surface before it freezes.

As a rock type, a 'granite' is described as being a plutonic igneous rock composed of the minerals quartz, mica and feldspar. All granites by definition have this basic recipe, but like ice-creams, they can come in all kinds of different flavours. Trace minerals and elements can alter the colour of the major minerals and grain size and shape can vary. Although a stone mason would call all the stones used here in Deptford Market Yard 'granites', geologically we have here three granites and a rock called a diorite. Luckily they are all easy to distinguish too, being different colours.



Luoyuan Granite (*top left*) has large pink and white feldspar crystals as well as quartz and a black variety of mica (biotite). It is from Fujian Province in SE China. It has an overall pink appearance and is a very striking stone.

Shandong Rust Granite is a yellow-brown granite which gets its name from rusty spots, stripes and patches throughout this rocks which have given an otherwise white granite a yellow to rusty-brown colour. The rust is due to iron which has percolated through the granite as it has become weathered.



Laizhou Granite (*below left*) is a rather unusual looking granite, with a medium-grained, grey groundmass made up of the three main granite minerals, quartz, mica and feldspar. However it is scattered with larger crystals, 2-3 cm long, of white and pink, well-shaped, feldspar crystals. Some of the pink crystals have white rims. The colour changes represent subtle changes in chemistry as the melt was crystallising. It is easy to mistake these larger crystals for chewing gum on the pavement, but the name for these large crystals in a fine grained groundmass is *phenocrysts*.

Zhangpu Green Granite is the odd one out here, it is a diorite, an igneous rock composed of feldspar, which is usually white or grey and a dark green mineral called hornblende, and this is why this stone as a grey-green colour. It has crystallised from a melt of a different chemistry from that of granites. However, to stone contractors, pretty much all igneous rocks are 'granites'.

Zhangpu Green comes from Fujian Province on the coast of southern China. Luoyuan, Laizhou and Shandong Granites come from Shandong Province on the coast of south east China. All were intruded during the Mesozoic era, part of the geological timescale that comprises the Triassic, Jurassic and Cretaceous Periods, the time of the dinosaurs! This was the time that the landmass that is now south and east China was being formed by plate tectonic processes. The South China Sea was being forced under the Asian continental crust building mountains along the new coastlines. During the Mesozoic, this part of SE Asia would have been like the Andean Mountains of South America today – high mountains and lots of volcanoes. The granites and diorites we have seen here would have been the plumbing, feeding magma to the volcanoes where it could be erupted as lavas and volcanic ash.

On leaving Deptford Market Yard, turn left along Deptford High Street. A small piece of evidence of English magmatism can be found on the can be spotted on the kerb.

Ffinch Street

A Victorian kerb stone made of **Cornish Granite** survives amongst the concrete on the corner of Ffinch Street and Deptford High Street (*below*). The Cornish granites did not feed volcanoes, but they did produce spectacular rocks which were widely used as building stones throughout the 19th Century.



The white, brick-shaped crystals are the mineral feldspar, one of the essential components of the granite recipe. The crystals here show some alignment. People once believed that this alignment was due to the solid crystals flowing in a liquid melt. However molten granite is extremely viscous, so much so that we would not think of it as a liquid. It has a consistency more like peanut butter. We now believe that these phenocrysts formed later in the crystallisation history of the granite and any alignment that we see is probably more likely to be related to deformation of the rock rather than flow.

If you want to see some fossils, then take a short diversion down to St Paul's Church.

St Paul's Church

St Paul's is a fine Baroque church, designed by architect Thomas Archer and completed in 1730 (see Cherry & Pevsner, 2002). It has a semi-circular portico, supported by columns at the front entrance and porches accessed by staircases on the north and south sides. Geologically we must now take a detour away from our igneous rocks and their associations with volcanoes, for the church is built from London's most famous building stone, **Portland Stone**. The 17th century architect Inigo Jones was influential in bringing Portland Stone to London. He used it to build the Royal Banqueting House on the Mall in 1620. After the Great Fire of London in 1666, use of Portland Stone took off and it was used by Christopher Wren to rebuild St Paul's Cathedral. From then on it became London's main building stone and it was often used for civic buildings and churches.

Portland Stone is a pale-grey limestone of latest Jurassic age, deposited 145 million years ago in warm, shallow, tropical seas, full of life. Evidence of this can be seen in the fossil shells that are easily spotted in this stone. Given this building is nearly 300 years old, the Portland Stone has weathered, and the harder

fossils now stand proud of the surface. These are oyster shells and the laminated structure of their shells has been well preserved. The presence of these fossils tells us that this is the variety of Portland Stone known as Whitbed.



Fossils in the stones of St Paul's Church. Top left and right, Portland Whitbed with fossil oyster shell fragments weathering proud of the surface. Bottom left and right, varieties of Purbeck Stone with various fossilised freshwater shells and algae.

Purbeck Stone is England's 'marble'. It is not a true marble in the geological sense but it is an architectural marble in the sense that it is a limestone that takes a good polish. It was very popular in ecclesiastical decorations. In the exterior of St Pauls, we see it as paving on the north and south side porches, which are accessed by symmetrical staircases. These areas are paved with a red, sandy limestone called **Mansfield Red**, from Nottinghamshire, Portland Stone and the varieties of Purbeck stone which are illustrated above.

Geologically the Purbeck Beds overlie the Portland Stone, marking not only a major change from marine to freshwater environments, but also the change from the Jurassic to the Cretaceous era. The fossils indicate this change in environment with freshwater snails and mussels taking the place of the seashell fossils found

in the Portland Stone. Purbeck Stone has also revealed rare fossils of reptile bone and insects as well as occasional dinosaur footprints. Purbeck has been quarried since the Roman period from quarries around the village of Langton Matravers on the Isle of Purbeck in Dorset. The beds are thin and there is a lot of variability in the appearance of the various stones and 'marbles' extracted from these strata.

Leave the churchyard and turn left back onto Deptford High Street. Retrace your steps back to the station and Tomi's Kitchen opposite the station end of Deptford Market Yard.

Tomi's Kitchen

Tomi's Kitchen Restaurant at 126, Deptford High Street used to be a pub, The Mechanics Arms¹, and it has very typical stonework for a London Pub (see Siddall, 2014). Pubs were intended to look smart and classy, but not too classy! No fancy marbles in London's pubs. The stone of choice was a colourful granite usually from Scotland or Scandinavia. Here at Tomi's Kitchen we have red, Scandinavian granites and in fact both here are originally from the east coast of Sweden. Like the ones we have seen above in the Market Yard, they have the standard quartz + feldspar + mica recipe. The two varieties are **Swedish Balmoral Granite** (below left) and **Graversfors Granite** (below right).



Both granites contain brick-red feldspars and the black mica, biotite. The white mineral in Swedish Balmoral Granite is quartz, and this gives the granite a red-and-white appearance that can be seen in the photograph above. Graversfors Granite on the right is more of a purple colour overall, and this is down to the quartz being almost violet in colour, partly due to the fact it has been crushed and also because there is a lot of iron oxide (the mineral hematite) in this too. These are extremely ancient rocks, almost two billion years old (1800 million years old). These are certainly the oldest things on Deptford High Street!

Continue down the High Street to Giffin Street.

Giffin Street

Here in the plaza on Giffin Street, we get to see solidified lava flows in Deptford. This stone is used for the cube seating blocks in the plaza. This is another Chinese stone called **Black Pearl Basalt**. A basalt is a volcanic igneous rock. Basalts are composed of the dark coloured minerals olivine, pyroxene and a variety of feldspar and are consequently black in colour. These basalts were erupted as enormous lava flows, fifty metres thick, during the Cretaceous, around 140 million years ago. These eruptions would have been

¹ The Lost Pubs Project: http://www.closedpubs.co.uk/london/se8_deptford_mechanicsarms.html

unimaginably huge, nothing like them has been seen in human history. The granites we have seen in Deptford Market Yard and their relatives, would have been the magmas feeding these enormous volcanoes which are true supervolcanoes. Their craters would have been 50 miles across and most of the eruptive products would have been volcanic ash and pyroclastic flows. Basalts were only a small proportion material erupted. However the solidified flows are still enormous, forming columns (which are typical of thick basalt flows) which can be seen in the quarries in Bailin in Fujian Province. These columns form as the lava cools and solidifies, and are up to 2-3 metres diameter (see below, right). As a result, large blocks with no cracks within them can be produced.



Above left; the porphyry basalt at Giffin Street. Right; The Black Pearl quarries in Fujian Province, China (photo from StoneContact <http://www.stonecontact.com/quarries-2209/china-black-basalt-quarry>).

Looking closely at the polished surfaces of the blocks and you can see that they contain black spots. These are phenocrysts of the mineral pyroxene. If you can see any green crystals, these are the mineral olivine, so named because it is olive green. You can also see that the groundmass is very fine-grained. This variety of texture in rocks is called a 'porphyry'.

Continue south along Deptford High Street.

Deptford High Street

The green paving cobble around the junction with Giffin Street and Douglas Way are **Zhangpu Green Granite**. The pattern of different coloured granites seen in Deptford Market Yard is once again used on the High Street; pink is **Luoyuan Granite**, grey is **Laizhou Granite** and the brown is **Shandong Rust Granite**.



The last stop on Deptford High Street on the corner of New Cross Road is the Broadway Restaurant, a riot of granites.

Broadway Restaurant

On the corner of Deptford High Street and Deptford Broadway, The Broadway Restaurant also had a former life as a pub, The Centurion². It is also clad in a variety of granites, three Scottish and one Finnish.

Peterhead Granite is the pale pink granite used for most of the square section pillars between the windows. As the name suggest it is from Peterhead, a fishing town north of Aberdeen on the east coast of Scotland. It has salmon pink feldspars and smoky grey quartz and looks a bit like coarse Ardennes pâté. Although no longer quarried today, this stone was very much in fashion during the Victorian and Edwardian periods and is used to clad a great many pubs and used as plinths for statues etc. It was intruded just over 400 million years ago during the formation of Scotland's mountains.

The grey granite panels between the windows are **Cairngall Granite** which also comes from Peterhead, and this was quarried close to the pink granite quarries at Flushing. The quarries are long since closed and are now a rifle range. Cairngall Granite is much older than Peterhead, at 475 million years.

Just next door to the main restaurant at 14, Deptford High Street the building scheme continues. At some time in the recent history of the building, there has been need to replace some of the Peterhead Granite, presumably because it was damaged. As it is no longer worked, it has been replaced using **Balmoral Granite** from Finland. This granite has crystals forming a mosaic of brick-red feldspars and dark-grey, almost black, quartz is one-and-a-half billion years old. It comes from the south-west coast of Finland.



The small pillars on each side of the door are made from **Dalbeattie Granite** from south-west Scotland also around 400 million years old. This has white a pale pink feldspars, black biotite mica and grey quartz. The pillar n the left hand side has a dark-grey, ragged patch in it. This is a feature that geologists call a 'xenolith' which literally means a 'strange rock'. It is not part of the granite, but part of the pre-existing country rocks that the melt was intruded into. Therefore it is a rock that is older than the granite that has not been incorporated into it and not dissolved into the granite magma (*left*).

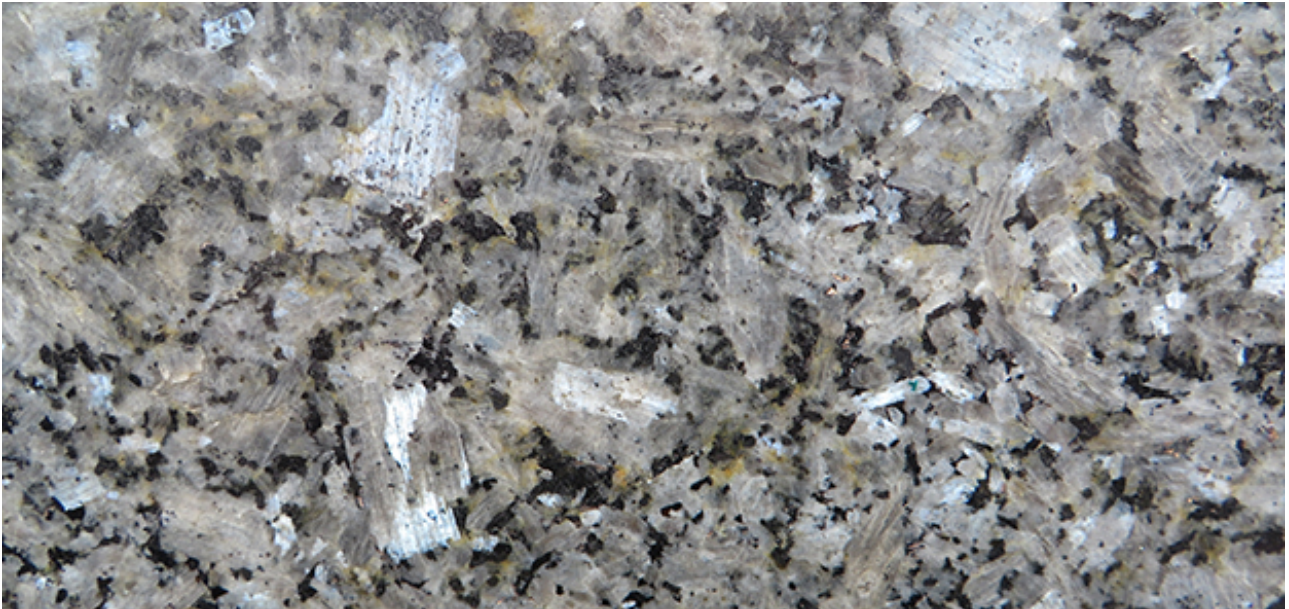
This is the end of the main tour of the urban geology of the area around Deptford High Street. However if you are heading towards New Cross, there are a few buildings worthy of geological note along New Cross Road. In London's suburbs, most building is in brick, but pubs and civic buildings are good places to spot some geology. The New Cross Inn and New Cross House are opposite each other, at the junction on New Cross Road and Lewisham Way.

New Cross Inn

Another early 20th Century pub, the New Cross Inn has its ground floor clad with a Scandinavian igneous rock. This time it is from the town of Larvik in southern Norway and it is named larvikite. Larvikite is not a granite because it does not contain any quartz. It is a variety of rock called a monzonite. It was intrude into the Oslo rift valley (now the Oslo Fjord) around 290 Ma during the Permian. Larvikite has been quarried in a commercial scale since the 1880s and as become very popular world wide as a strong, hard-wearing and very attractive stone. It is famous for its iridescent feldspars which shimmer and change colour as you

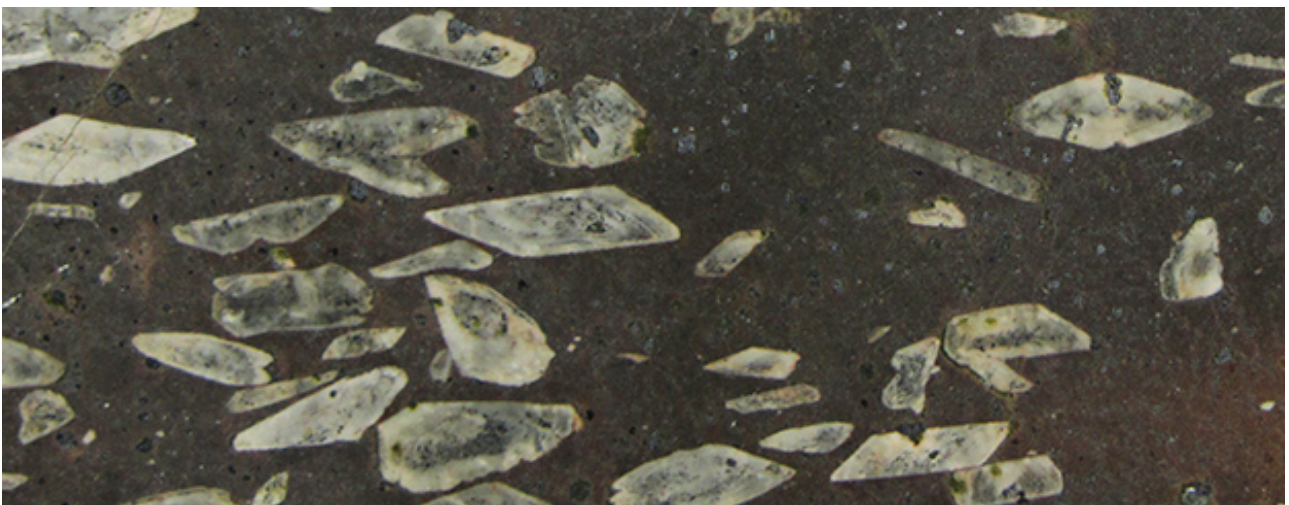
² The Lost Pubs Project: http://www.closedpubs.co.uk/london/se8_deptford_centurion.html

move your head; sometimes appearing grey and sometimes electric blue. A number of varieties of this stone ranging in colour from almost black, through blue to grey are quarried. This is the grey variety which goes by the name **Marina Pearl Larvikite**. The image below shows the grey, iridescent feldspars. The black minerals are biotite mica (which we have seen in some of the granites) and pyroxene (which we saw in the basalt in Giffin Place).



Larvikite on the New Cross Inn.

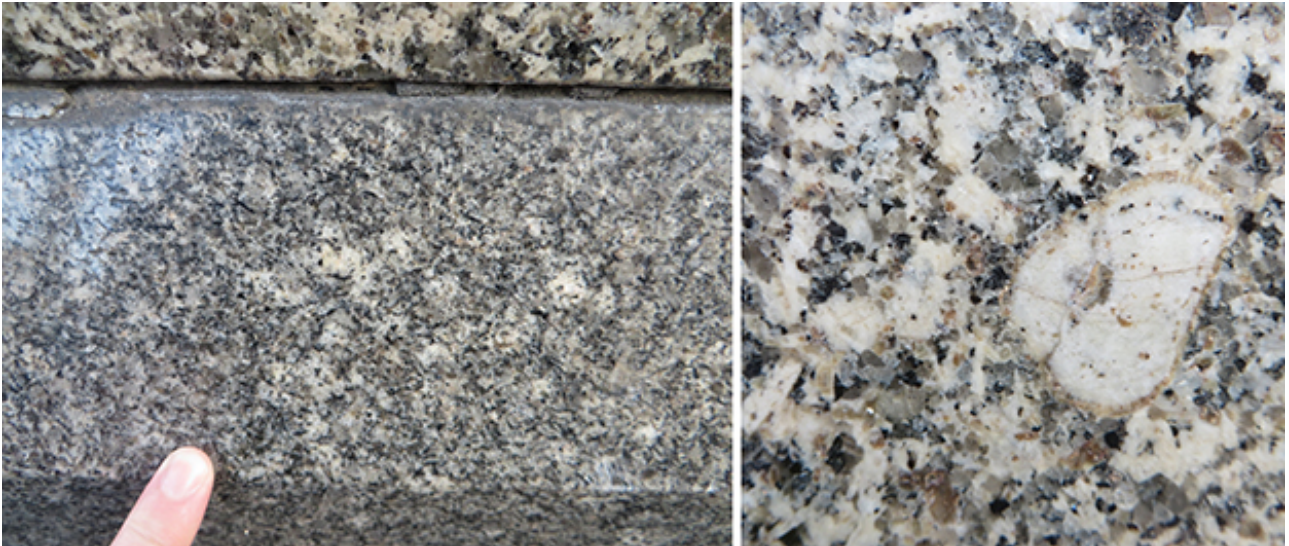
We know that the larvikite magma chambers of the Oslo rift were definitely feeding volcanoes. We see the products of these volcanoes which still survive as solidified lava flows, with very distinctive diamond-shaped or rhombic feldspars. These rocks are known as the 'rhomb porphyries' and they are a variety of lavas which geologists call latites. They are unique to the Permian magmatism of the Oslo rift. During the ice ages, these volcanic and plutonic rocks were heavily eroded (and this process helped to expose the larvikite intrusions). Chunks of rhomb porphyry were carried south by glaciers and ice sheets and dumped in moraines and glacial sediments when the ice sheets melted. They can now be found in the glacial gravels of SE England, and because of their uniqueness, we know exactly where they came from. This has given us lots of information about how far, how fast and in what direction the ice sheets moved.



A polished slab of rhomb porphyry frozen lava in the National Museum of Scotland. The largest crystals are 1 cm long. Photo by Ruth Siddall.

The New Cross House

Across the road from the New Cross Inn is the New Cross House. This is clad in British granites; **Merrivale Granite** from Dartmoor and **Cairngall Granite** from Peterhead in Aberdeenshire, Scotland. We have seen Cairngall earlier on The Broadway Restaurant. Merrivale comes from the other end of the British Isles and is one of the suite of granites intruded into Devon and Cornwall around 300 million years ago. It has large white feldspar phenocrysts and slightly brownish quartz. Cornish granites typically have two types of mica; the black biotite and a silvery variety called muscovite. This can be seen sparkling in the rock, especially if the sun is shining. Merrivale Granite was quarried by the prisoners incarcerated in Dartmoor Prison.



Stones on the New Cross House. Left; Cairngall Granite and right; Merrivale Granite.

Deptford Town Hall

Like St Paul's Church, the old Deptford Town Hall building is constructed of **Portland Stone**. The intricate carving above the main door is enabled by Portland's properties as a freestone, that is, a stone which has no preferred weakness and therefore can be carved in any direction. As a consequence, elaborate and intricate carvings, as observed in this fishy coat of arms, representing Deptford's maritime associations (*below*). The building was designed by architecture firm Lanchester Stewart Pickards and built in 1905.



References

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- Grattan, J. P., Gilbertson, D. D. & Dill, A., 2000, A fire spitting volcano in our dear Germany? Documentary evidence for a low intensity volcanic eruption of the Gleichberg in 1783, in: McGuire W. G., Griffiths, D. R., Hancock, P. L. & Stewart, I. S. (Eds.) *The Archaeology of Geological Catastrophes*, Special Publications, Geological Society of London, 171, 307-315.
- Siddall, R., 2014, London's pub geology: a spotter's guide., *Urban Geology in London No. 20*, 18 pp., <http://ruthsiddall.co.uk/Walks/PubGeology.pdf>

Glossary

- Basalt** – a volcanic rock composed of the minerals feldspar, pyroxene and olivine.
- Diorite** – a plutonic igneous rock composed from the minerals feldspar and hornblende.
- Freestone** – a rock with no planes of weakness, meaning it is very good for three-dimensional carving.
- Granite** – a plutonic igneous rock that is composed of the rock forming minerals quartz, feldspar and mica.
- Igneous** – a type of rock that has formed by the crystallisation (freezing) of a silicate melt.
- Lava** – a silicate melt on the Earth's surface, erupted from a volcano.
- Magma** – a silicate melt within the Earth.
- Mineral** – a solid material with a defined chemical formula.
- Phenocryst** – a large crystal in a finer grained groundmass in an igneous rock.
- Plutonic** – referring to an igneous rock which has formed within the Earth's crust.
- Porphyry** – an igneous rock with phenocrysts, which therefore has a speckled appearance.
- Pyroclastic flow** – a torrent of rock fragments and ash produced by a very explosive volcanic eruption.
- Rock** – a solid material made up of minerals.
- Stone contractor** – the business that liaises with a quarry to supply stone at the request of architects.
- Volcanic** – referring to an igneous rock which has been erupted onto the Earth's surface.

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- Laizhou Granite** – Deptford Market Yard, High Street.
- Lincolnshire Limestone** – St Paul's House
- Luoyuan Granite** – Deptford Market Yard, High Street.
- Mansfield Red** – St Paul's Church



- Marina Pearl Larvikite** – New Cross Inn
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Deptford Market Yard and Carriage Ramp.

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Locations of the buildings described above and brief details of the stones used can also be found in the London Pavement Geology website: <http://londonpavementgeology.co.uk>